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ENTERED AT POST OFFICE, NEW YORK, AS SECOND CLASS MATTER.

Three-Spindle Drilling Machine, with Traverse Table.

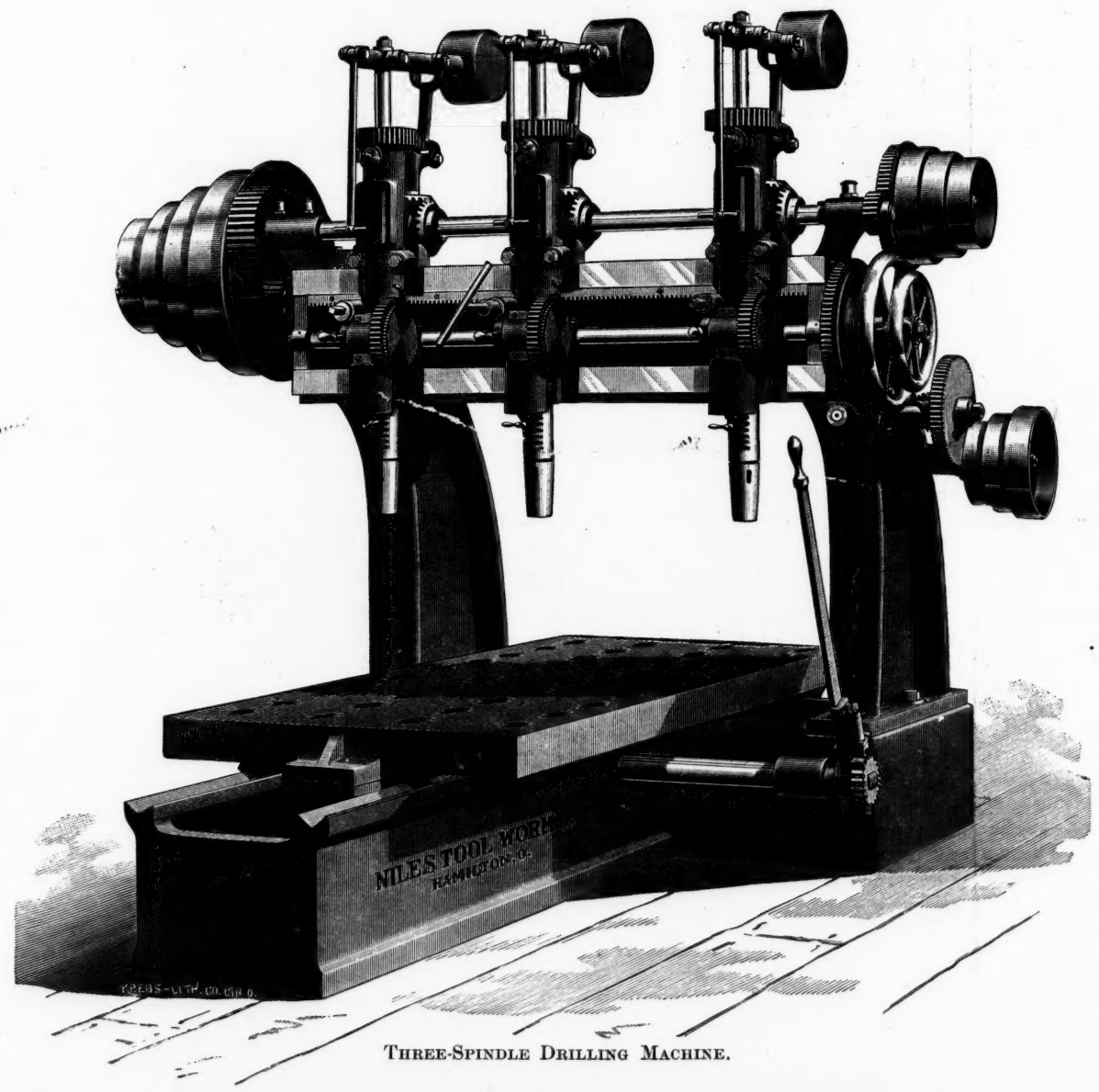
We illustrate herewith a new tool designed and built by the Niles Tool Works, of Hamilton, Ohio.

The drill spindles are placed on a fixed rail, and are adjustable lengthwise. They may be brought to within 7½ inches from center to center. The spindles have 12 inches travel and each has hand and power feed.

A four-step cone of large diameter, and strongly back-geared, transmits power to the spindles and gives ample power for drilling three 1½-inch holes at the same time.

A bed and table similar to the bed and table of a planer are used for supporting the work. The table is moved along the bed under the drills, adapting it to drilling a series of holes in heavy work, such as vault doors, etc.

The drill was specially designed for use in safe works, building heavy vault work, and for such work it is a desirable tool, as it saves labor and time.



THREE-SPINDLE DRILLING MACHINE.

A Pleasant Meeting.

The Engineers' Club of New York tendered a reception on the evening of Aug. 20, to the returning engineers—civil, mechanical, mining and electrical—who visited Europe this year at the invitation of European engineering societies. The affair was, as might be expected, a success in every way. In the absence of the president of the club, Mr. Burden, James C. Bayles presided, and he acquitted himself of the honors in a felicitous manner, which only means that he made his usual effort.

A good many speeches were made upon the occasion, as is customary in America at such times. It would be impossible to refer to all of them, so in the main they must be left unnoticed.

Some points were, however, brought out by Mr. Geering, the English engineer who has had to do with the construction of the steamship City of New York, of the Inman line, that are worth particular reference. Mr. Geering spoke of a good many things in relation to steamship construction, but what he said in reference to crossing the Atlantic in five days was the most noteworthy. In order to do this, he said, taking into account the adverse conditions which must always be considered, the engine power must be forty thousand horse-power.

This is something that is worth a good deal of consideration. There is an immense amount of talk about the possibility of rapid ocean transit, but few ever stop to consider what it means. Think of the space required to furnish 40,000 horse-power in an ocean steamship, then consider that these steamships are not built to demonstrate what speed is possible. There is the commercial side of the question, and that is the side that the engineer does not always look at. A steamship that would, unloaded, cross the Atlantic in four days, would be a curiosity, and nothing more. She must cross the Atlantic in that time with a freight of some kind that will pay the coal bill and other bills, or she is a failure. There is a good deal more in the problem of rapid ocean transit than has generally been considered.

President Towne, of the American Society of Mechanical Engineers, made some excellent points in relation to the European trip of the engineering societies. One of these was the manner in which the American societies were received abroad. We have refrained from saying much about this, because of the impossibility of doing the subject justice. Just now the only thing we can say is that American engineers will try and get even with their European friends if the opportunity ever comes.

But perhaps the pleasantest thing in Mr. Towne's remarks was his reference to what he had heard in regard to the manner in which European engineers, coming individually to this country, had been received here in past years. But this is nothing to what is to come if we are to take the expressions of the engineers present at the meeting of which we are speaking as an evidence.

Mr. Towne, in his admirable address, spoke of the efforts of English engineers to make the stay of their American friends pleasant in all ways. He mentioned the names of English engineers who had devoted their time to that purpose, and he spoke particularly of the efforts in that direction of Mr. Dredge, of *Engineering*. The efforts of this gentleman were untiring. He was ubiquitous, and whatever he was engaged in carrying out was well done, always.

Altogether the effort to receive the returning engineers was a success. It is impossible in our limited space to dwell at length upon the matter, but it would hardly be proper to cease without referring to the last speech of the evening, viz., that made by Mr. Raymond, secretary of the mining engineers. Mr. Raymond detailed at length what had been done by the mining engineers who stayed at home, and gave an account of their meeting in the West, and a trip of a few of them through California. What he said fairly electrified his audience. Mr. Raymond is a fluent speaker, and his graphic description of California scenes was something that will be remembered by his hearers. Mr. Raymond's address very appropriately concluded the evening's entertainment.

Shop Notes.

Visiting Hartford, recently, we found the Pratt & Whitney Co. quite busy, and just inquiring around among the men to find out how many would be willing to work nights, and what the general preference would be as to the number of hours and number of nights per week; a proceeding, by the way, which will, no doubt, seem somewhat strange to those of our readers whose experience has been entirely upon railroad work, where it is almost the universal practice to assume that the entire time of the men is at the disposal of the company, and can be called for at any time—a practice which has, of course, developed from the necessities of railroad work, but which is sometimes greatly abused.

Among the other large contracts at present on hand at Pratt & Whitney's is one for $16,000 worth of tools for the new shops of the Westinghouse Air-Brake Co. The work on the revolving and rapid-fire Hotchkiss guns for the Navy Department is employing quite a number of men, though it does not interfere with the regular lines of work, because the gun work is confined to the building which was erected across the street from the offices of the company for warehouse purposes, it being still called the warehouse, though the growth of business has forced work into it until its interior resembles a warehouse much less, and a shop much more than many buildings do which were erected for, and are called shops. At the time of our visit the work was mainly upon the six-pound rapid-fire gun, which is not a revolving gun, but has a single barrel 90 inches long, 2.24″ diameter of bore, rifled with 24 grooves .012″ deep, and with a uniform twist of 6°. The ball is of tempered steel, and the breech mechanism is so arranged that 15 to 20 shots per minute can be fired. The gun is composed of two principal parts—the tube and the jacket. The latter is bored out to receive the tube, which is put into it by shrinking and finally further secured by a collar which screws onto the jacket and engages with a shoulder formed on the tube. The portion of the tube which fits into the jacket is 26¼″ long and 4.92″ diameter, the maximum shrinkage allowed being .004″. This is not uniform, but varies at different places to make the compression of the different portions of the tube conform to the pressure curve. It is found that the pressure of the jacket upon the tube closes the bore about .002″, which is afterwards reamed out.

The operation of shrinking the jacket onto

the tube is unattended with any of the excitement and nervousness often seen when shrinking fits are being made in engine building and other shops, though the results of a failure would be more serious than in the case of most jobs of crank fitting. And, with the appliances for doing the work, there would seem to be small occasion for any nervousness resulting from doubt of success.

In a vacant space in the boiler house beside one of the boilers, upon a solid foundation rests a heavy iron block, the top of which has been tooled off smooth, and is set level with the floor. Upon this rests a hollow ring of cast-iron, from the upper side of which rise eight pipes to a height about equal to the length of the jacket. Projecting from the inner sides of these pipes towards the center are Bunsen burners, there being just room to let the jacket down vertically in the central space, so that it stands on end upon the block; into the hollow ring a blast of air and gas is forced, which, rising in the pipes, feeds the burners, of which there are in all forty-eight. Inside this ring of pipes, and diametrically opposite each other, are two steel standards or heavy bolts, having at their tops solid heads. These are secured to the block below, and some of the burners are directed towards them so that they are heated, and, of course, expanded at the same time that the jacket is. A windlass is fixed upon the wall at one side of the room, the steel wire cable from which passes up to a trolley and down, so that the parts of the gun can be readily handled by one man, the crank of the windlass driving it by means of a worm and wheel. The jacket being in place upon the block surrounded by the Bunsen burners, those towards the bottom are first lighted, both because the jacket is heaviest there, and the heat naturally has a tendency to work upwards by the ascending currents of heated air. The steel of which the jacket is composed being tempered, great care is taken to prevent over-heating, and to do this a gauge and a thermometer are used. The thermometer is suspended from the under side of a sheet metal disk, which, when in place, covers the top of the jacket and prevents currents of air inside the bore. The thermometer thus hangs in the center of the bore, and when lifted up shows the temperature of the confined air, which it is allowed may be about 50° cooler than the jacket itself. The gauge—which touches the bore at four points—is set to a size which will just let the tube in easily, and the heating proceeds until this gauge, which is at the end of a light steel rod, will pass freely through the bore. When this occurs the thermometer shows that the heat is not sufficiently high to draw the temper. In the meantime the tube has been suspended from the trolley, and hangs at one side ready to be dropped into place. Its lower end has been plugged up with wood, and to the top or muzzle is attached a cap of bronze which clamps on water-tight, and is arranged to take water from a hose which is atttached to it at one side, and conduct it down through a brass pipe which extends to near the bottom inside the tube. It then rises through the tube and out through the cap to a hose attached to the other side, the end of this hose having a nozzle by which the stream is directed onto any desired part of the jacket. This cap is attached to the tube so securely that it answers to suspend it by, there being an eye at the top to which the hook is attached. At a point on the tube a little above where the top of the jacket will come, is a heavy yoke of steel, which is secured to the tube, and inside of which, and also surrounding the tube, is a threaded sleeve of bronze, which, when turned, forces the yoke up or down. At the moment the heating has proceeded to the right point, the tube is swung into position over the jacket, and lowered until they nearly touch. Then, by means of a cam, one of the bearings of the winding drum is raised, disconnecting the worm-wheel from the worm, and letting the tube drop full force into the jacket, being stopped by the shoulder before spoken of. The yoke is now quickly swung around so that its ends pass under and engage with the heads of the two steel bolts previously described. The threaded sleeve is then turned until the yoke is drawn up tightly under the bolt-heads. The bolts are then cooled off along with the jacket, for the purpose of keeping the shoulder between the end of the jacket and the tube closed up tight. As soon as things are in place the water is turned on, and, by the previously described arrangement, cools the gun off chiefly from the inside, preventing the tube from becoming much heated by contact with the jacket. About thirty-five minutes' time are required for the job. Lieut. W. W. Kimball, of the U. S. Navy, inspects and passes upon almost every operation upon every piece, and the requirements as to workmanship are of the highest. The tubes, besides, being star-gauged to determine their diameter at every point, have a closely-fitted plug gauge six diameters long passed through them to detect any short and slight deviations from exact straightness there may be. Any piece is liable to be rejected at any stage of its progress, and finally the gun may, when completed, be rejected; the final test being a firing test, in which accuracy of fire and penetration are taken into account. The rifling in these guns is done by newly designed machines, which are the largest and finest ever built specially for rifling; the quality of the work done by them being the very best we have ever seen.

At the Dwight Slate Machine Co.'s place we find them quite busy upon regular lines and special machinery — Mr. Slate himself being at present engaged upon the drawings for a new rack-cutting machine. They have somewhat outgrown their present quarters, and Mr. Slate laments the scarcity of room which prevents him from keeping things in just the shape he would like to. Noticing that cast-iron was to be used upon some of the parts of the rack-cutter which almost any other builder would use some other metal for, we entered into a conversation with Mr. Slate upon the subject, and found him to possess great faith in the wearing qualities and general desirability of cast-iron running upon cast-iron. He uses it because he thinks it better than any other metal for shafts and spindles, which are made almost universally of wrought-iron or steel. He was led to this conclusion as the result of study first induced by an incident which occurred "along in the forties," when he was building machinery down in Massachusetts. He called at a mill one day to see about some work, and there saw a machine which had originally been built with wrought-iron journal bearings which had become worn, and about fifteen years before had been turned down and cast sleeves put on. These were turned to a nice fit in the boxes, and after running fifteen years were still nice fits. This led him to experiment and observe closely, with the result that he firmly believes that cast-iron journals running in cast-iron boxes properly proportioned to maintain a moderate pressure, and properly lubricated, are about the best attainable bearings. But he says the journals must be finished by a light cut, with a square-nosed tool, and at a high speed, no filing or grinding being done upon them. Of course there will be plenty who will differ from Mr. Slate in opinion on this point, but the least that can be said is that such an opinion, held by an engineer of Mr. Slate's ability, as the result of actual experience during so many years, is not to be lightly passed over, but is entitled to considerable weight.

Mr. Slate walked down with us to the shops of the National Machine Co., a company which is controlled and managed by two men who formerly worked for him. They are at present doing some very interesting work upon what are called the Automobile torpedoes, several of which they have built for foreign governments, and a number now being in course of construction for our own Navy Department. They are immense copper cylinders pointed at each end, and literally filled with machinery and other things, among the latter being 400 pounds of nitro-glycerine, which is arranged to be exploded upon contact or at the will of those who control the movements of the torpedo, which is done from shore or a vessel. A multi-cylindered engine of very peculiar construction is used, which drives a finely-polished two-bladed bronze screw propeller at the stern, the shaft being a hollow tube through which the exhaust takes place. There are no connecting rods upon the engine, but the cylinders are arranged like the cylinder of a revolver, at equal distances from the shaft, with which all the cylinders are parallel. The guides are round bars—two for each crosshead, and attached to the lower side of each crosshead are two large steel rollers, which engage in a cam placed on the shaft. The motion of the pistons is so timed as to keep the shaft in continuous motion, the ports of all the cylinders being opened and closed by a single valve which is fixed to the shaft. A very high pressure is used, the heat being furnished, not by an ordinary fire, but by the mixing of lime with an acid, the mixture then surrounding a coil of pipes. Though the torpedo is to be really used but once, and is of course never heard of after once using, the work upon it is excellent, though everything else is sacrificed to the attainment of the best possible performance for a few moments only. The engine may, however, be used some in practicing with the torpedo.

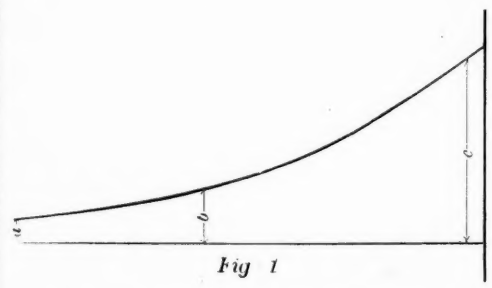


Fig 1

The Hot Air Fallacy in Boiler Furnaces.

By W. H. Booth.

Before combustion can take place it is absolutely necessary that the materials which unite to form a fire must become heated to the ignition point. Once thus far heated combination occurs, and the heat thus evolved goes to perform useful work and to raise to the ignition temperature a further quantity of air and fuel. Reasoning on this basis, and with perfect correctness, certain engineers and others have argued that, as air, to support combustion, must first obtain a certain amount of heat from the already incandescent fuel, it must be the proper course to heat the air before bringing it near the fuel. By doing this, and utilizing heat which would otherwise be wasted, to do so it is claimed that better combustion and economy will result.

Though it is now known that such results do not accrue, yet the theory is correct, and so would be its practice under proper conditions.

The cold air men, on the other hand, who are usually ignorant, point to the well-recognized fact that a fire burns brighter, clearer and smokeless with cold air, especially on a very cold day. Such men are worse than the hot air men, for usually they can see no further than their noses, and actually believe that cold air is absolutely essential to proper combustion, whereas the exact opposite is the case. It is unfortunate that on the first blush the more ignorant section appears in the right.

As a fact, both are wrong, and they do not know they are wrong, simply because they are not alive to the importance of, not merely the quality of the air, but its quantity relatively to the fuel to be burnt. Some time may usefully be spent in inquiring into the true facts, so that we may understand what actually does take place in a furnace, and why improvements—so called—in methods of working do not prove so when put to the test of daily work.

In the first place, combustion occurs in all ordinary furnaces by virtue of the draught induced by the chimney. The draught is caused by the tendency of the column of heated gases in the chimney to rise, or rather because the gases in the chimney, being of less gravity than the external atmospheric air, are pushed upwards by the cool outside air, until the whole chimney is reduced to the condition of the atmosphere as regards temperature. Any hollow vertical column, if hotter than the atmosphere, will have an upward current in it if an inlet is made at its base. If colder than the atmosphere there will be a downward draught, such as often noted in a fireless household chimney if the base is open to the room, should a sudden hot day follow a period of cold, the material of the chimney being colder than the atmosphere. In a furnace, the condition of a column of air ascending, which shall always be hotter than the outer atmosphere, is secured by passing the inflow current into the chimney base through and over a fire. Hence it is not the chimney, but the furnace which causes draught by heating the rising column, the chimney merely serving to separate the rising column from the outer cold air. A long chimney is better than a short one, because it protects a higher rising column.

As in cold weather there is a greater difference of temperature between the outer air and the rising hot column, so will the draught be greater; and here we see one cause of the better combustion which is secured in cold weather, and which has no cause in the low temperature of the air which supports combustion further than we shall soon see.

We now see that the current of air flowing through a furnace proceeds from the gravity of the air, not from any power of suction possessed by the chimney. This latter seems to be the case, because, wherever an opening is made into a flue between the furnace and the chimney, air will rush in as if drawn. Actually it falls into such an opening of its own gravity. If a very sensitive vacuum gauge is applied to a chimney, a flue or a furnace, there appears to exist a partial vacuum, but reason would seem to teach us that this is caused on the induction principle, the rush of gases past the end of the pipe to which the gauge is connected inducing the apparent vacuum. If it was really possible for a vacuum to exist at the foot of a chimney, it would exist equally well at the base of any vertical hot pipe *closed at the base*, whereas common sense alone teaches us that this cannot be. Testing a draught at the chimney base and at the furnace mouth shows very different results, for the rapidity of flow of the mixed gases must be much greater where hot than where cold, as so much greater a volume has to pass when hot than when cold, and hence the inductive power is more also, and a vacuum gauge showing the amount *a*, in Fig. 1, at the furnace, might show as much as *b* at the half length of flues, and *c* at the chimney foot, if contracted at a small damper opening.

If the flues and tubes of a boiler are narrow and crooked they will offer great obstruction to the free flow of the hot gases, and spoil the draught. Hence the necessity of wide, roomy flues and chimney.

Now when air enters a furnace at the ordinary temperature of say 61 degrees, or 500 degrees absolute, and leaves it at 561 degrees, or 1,000 degrees absolute, it has doubled its volume. In the furnace itself the absolute temperature may be 2,500 degrees, so that the volume passing over the bridge is perhaps five-fold that which enters the furnace. This accounts for the high speed of the gases past the bridge. They are traveling slowly when cold and heavy, and when heated and light continue to travel at such velocity as shall pass an equal weight through an equal area in the same time. Thus their velocity is inversely as their gravity.

If now, in order to obtain easier combustion, we supply air already heated to 1,000 degrees absolute, or 561 degrees Fahr., instead of cold air at 61 degrees Fahr., what do we really effect? We double the bulk of each pound of air. By doing this each atom of oxygen, which alone supports combustion, is placed at double the distance from adjacent particles, and so we reduce the power and intensity of its combination with the fuel.

If at the same time as we double its volume by heat we compressed it by mechanical means to its original volume, then we should

soon see what a powerful aid to combustion a hot blast may become; but under ordinary circumstances, with a natural draught, this very simple explanation is enough to show why nothing is gained by heated air; for though, by increasing its volume, we diminish it weight, and so make it easier to push it through the bars per unit of volume, still we increase its volume, and thereby increase the length of the thousands of entering streams of air with their surface for friction, as they pass through the bars and the fuel on the bars.

Amongst engineers accustomed to gas engines it is well recognized how the compression in the cylinder of a very dilute charge will cause a charge to explode which would not do so under ordinary atmospheric pressure. The compression brings into more intimate contact the particles to combine, and the effect is parallel with that of cold air in a furnace. Just when and how combustion takes place is not fully clear, but, though it must always remain a fact that air has to be hot before it will combine with fuel, still it seems equally a fact that the accession of temperature must take place in immediate contact with the fuel, or the bulk of air must be reduced by pressure if heated.

The hot blast for iron smelting is economical, but in the blast furnace the draught is decidedly forced, and it is cold air that passes through the blowing cylinder, the heat being applied afterwards. In the application of heated air to ordinary furnaces, so far no power has been employed to compel the air to move forward, other than the natural draught, and under such circumstances no saving of fuel can be effected in practice. At the same time, whilst recognizing that cold air gives the best practical results, it should not be forgotten that this is not due to the fact that the air is cold in itself, but to other interfering and concurrent causes. Hot air, if heated by otherwise waste heat, implies an economy, just as does a hot feed water similarly obtained; but if, by heating the air, we prevent its entrance in sufficient quantity, then will imperfect combustion ensue, and waste. We may readily understand that there is reason in keeping a cool ash-pan, and would add that upholders of hot air should not forget that for each square foot of grate surface the best fire-bar does not give above half a foot of air space, and that this is more or less blocked by ash, clinkers and fuel.

Such Things Will Happen.

There was an exciting time at the new power station of the Troy and Lansingburgh Railroad, in Lansingburgh, Thursday, and for a time those present wished themselves anywhere else. The new boilers and engine were being tried for the first time, and several of the directors and other officers of the road, besides the ubiquitous "investigators" who haunt the station to watch the progress of the work, were there. All gathered in the boiler room after the fires were lighted and awaited events. The dial of the steam gauge was eagerly examined, but there was no movement of the indicator. The sound of the accumulating steam began to be heard in the pipes; yet the hand of the gauge did not stir. The experts present began to look troubled, but the uninitiated were not aware that anything was wrong. Suddenly a tremendous noise broke in upon the comparative silence, and almost simultaneously experts and novices rushed to the door, crowding and pushing in their eagerness to get away from the impending peril. It did not take long for the superintendent and his assistants to collect their wits, return and bank their fires, and then inform the stampeded spectators, who by that time had succeeded in making their exit, the cause of the difficulty. It was merely that the steam gauge had not been properly adjusted and had refused to work. The tremendous noise was from the safety-valve, which was set at 100 pounds pressure and was showing that nothing troubled its working. Another incident occurred the same afternoon, which shows how even experts may make blunders. The condensing engine was being tested, but it absolutely refused to work. Everything was tried to remedy the difficulty. Finally, after half an hour's study, it was decided that the pipes underground must be dug up, and arrangements were made for this undertaking. At this point, however, the superintendent happened to glance at the valve which governs the whole operation, and found that it had not been opened. When this was done the engine worked to the greatest satisfaction.—*Troy Times.*

Fig. 1.

Fig. 3.

Lathe Dogs.

Something New in Lathe Dogs.

The ordinary lathe dog, gripping by the point of a set screw, possesses serious faults, which have been put up with for so many years that the faults have come to be looked upon as something really belonging to lathe work. A wrench is required to tighten the dog, and a wrench is required to loosen it. If an extra heavy cut be taken the wrench must be called into play again, to give the dog an extra tightening. If a slight twisting takes place the set screw may slacken a little, and the wrench is again called into play. The action of the set screw in an ordinary dog is such that few set screws can stand the work for any length of time. Every latheman knows the result when the set screw begins to upset. If the set screw was at once removed when this occurs, and a new one, but nothing could more perfectly indicate the tenacity of grip of this dog. The figures on the above piece will indicate the extent of the work done. The merit of the dog will be appreciated when it is understood that the set screws are *thumb screws*, and that the bruising of the work, even with this heavy cutting, is so slight as to be ignored, except on the finest finished work.

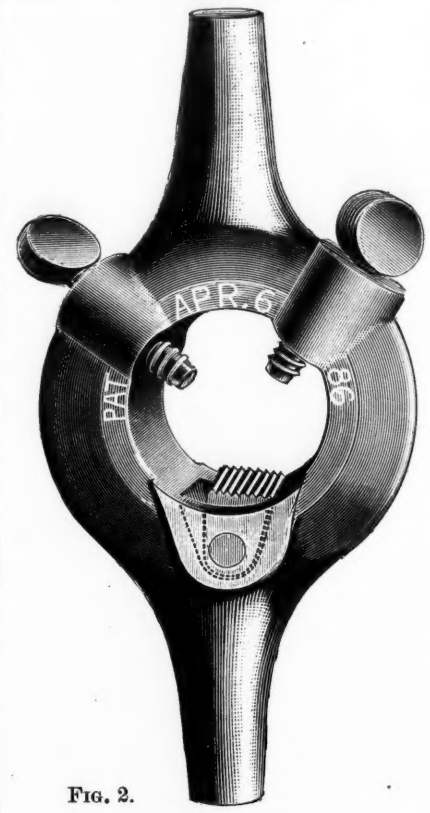


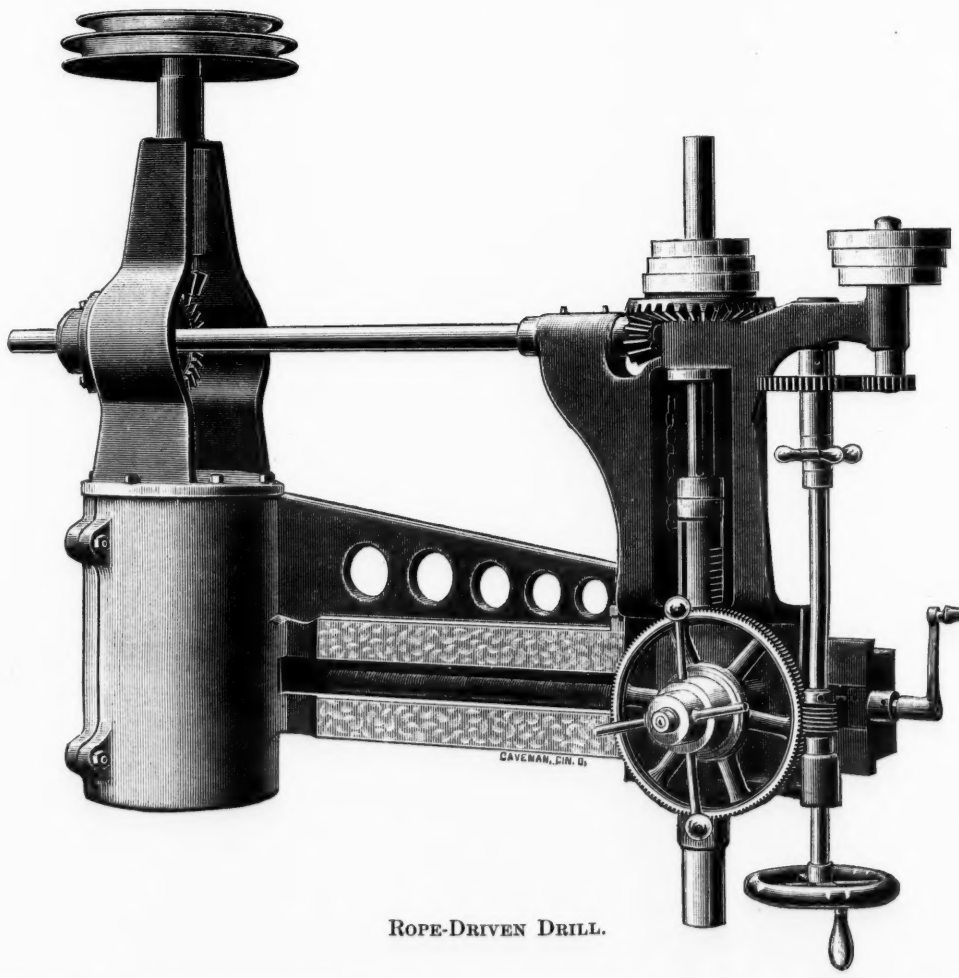
Fig. 2.

and good one substituted, things would not be so bad, but it seems to be an established law of all shops to keep the old set screw in the dog as long as it can be used at all. Old set screws, when upset, will not screw out far enough. When the ends split off the result is sad indeed. The best and most perfect of set screws bruise the work fearfully if heavy cuts be taken, but when the end of the set screw is broken or otherwise out of order, the damage is increased many fold. The careful lathesman fully recognizes the merit of coppers under the set screw, but the coppers are a nuisance, and, besides, are slippery on heavy work.

Fig. 1 represents a piece of lathe work, taken from a photograph, illustrating the grip of what is known as Shartle's bulldog. The word bulldog is not a very nice

Fig. 2 represents the Shartle lathe dog. It is shown with two straight tails, but these dogs are in the market with two straight tails or with one straight tail, or with one straight and one bent tail. This latter form possesses many points of merit, and is illustrated in Fig. 3.

In these dogs there are two set screws, which are mere thumb screws. Their office is to adjust the size of the dog rather than to perform the gripping work of the usual screws. In the face of the bore of the dog, opposite the set screws, is a pivoted jaw with a serrated face, the face being practically a double eccentric with regard to the pivot of the jaw. By screwing down the set screws the work is clamped between the set screws and the jaw, but not with very much force. The merest trifle of rotation of the work causes a tipping of the jaw, and the work then becomes subjected to powerful compression. The grip is an unyielding one so long as rotative strains are applied, but the work never jams in the dog; the thumb screws are always easily unscrewed. These dogs are especially useful where they are to be used on tapering work, in which case a jaw with a tapering face is used, thus giving a fair clamping bearing on the taper. The jaws are very easily removed. There is no strain on the pivot of the jaw, the heel of the jaw fitting fairly in the bottom of its recess. The recess is closed at one face by a plate sliding in a dovetail. This plate can be pulled out, and the jaw can then be removed if a taper one is to be inserted. The body of the dog is a steel casting, and the other parts are of drop-forged steel. These dogs are now getting into quite common use, and are in the market in sizes from ½ inch to 8 inches. They are manufactured by the Middletown Machine Works, of Middletown, Ohio.



Rope-Driven Drill.

Rope-Driven Drill.

The engraving herewith represents a new rope-driven wheel center drill, made by the Universal Radial Drill Co., Cincinnati, Ohio. It is useful in drilling the centers of hubs of built-up or segment wheels, or for doing work in special cases that would be difficult to take to the machine. The sleeve is bored to go over a 10″ stump, which may be permanent, or having flanged base, which can be bolted to the work in hand. The inner radius circle is 13″ from the center of the stump; the outer radius circle is 43″ from the center of stump. Traverse of the spindle 15″. It has power feed, quick-return and balance spindle.

There is something to be said pro and con as regards the pilotage of naval vessels. When piloted by their regular officers they frequently knock holes in themselves, and otherwise come to grief. So far as this goes it would probably be cheaper to pay for pilotage. But, on the other hand, officers of naval vessels should, if occasion requires, be able to take their vessels anywhere that there is water enough to float them. After all, it is perhaps best to give them the experience, even if it does make work at the navy yards.

Almost literally thousands of small steamboats — passenger boats — may be seen on the Seine in the vicinity of Paris, that carry one back to the days of the packet boats as formerly used on canals in this country. These boats are steered by means of a long tiller, and they are not very much larger than our packet boats were. The way these boats dodge one another, and the bridge piers in the river, show that the old-time tiller has some good points, or that the men who manage it know their business. The fare on these boats is low, and on Sunday especially they are exceedingly well patronized. They do not run at very high speed, still they are not what would be called slow.

Practical Drawing.

BY J. G. A. MEYER.

EIGHTY-FOURTH PAPER.

Problem 94.

612. *Developments of the convex surface of pyramids.*

A part of Fig. 496 (last paper) is shaded, and the remaining part is simply represented by broken lines; this was done for the purpose of making a distinction between the portions of the pyramid which are separated by the cutting plane $e_2\ e_4$; hence the shaded part in Fig. 496 and the elevation in Fig. 496*a* are the projections of the same portion of the pyramid. It will now be instructive to find the development of this shaded portion of the pyramid, thereby calling attention to facts which are liable to be overlooked by the student.

First find the development of the whole convex surface of the pyramid as explained in Art. 581, and thus obtain the development in Fig. 499, which is bounded by the straight lines $v_3\ D_3$, $D_3\ a_3$, $a_3\ b_3$, $b_3\ c_3$, $c_3\ d_3$ and $v_3\ d_3$. The lines $v_3\ a_3$, $v_3\ b_3$ and $v_3\ c_3$ divide the whole development into sections, each one representing one of the lateral faces of the pyramid; consequently $v_3\ D_3$ and $v_3\ d_3$ are represented in Fig. 496 by the line $v_2\ d_2$; $v_3\ a_3$ is represented in Fig. 496 by the line $v_2\ a_2$; $v_3\ b_3$, by $v_2\ b_2$; and $v_3\ c_3$ by $v_2\ c_2$. Now, it will be noticed that the cutting plane $e_2\ e_4$ in Fig. 496 cuts the edge $v_2\ b_2$ in the point f_2, and the vertical projection of this point is represented by the point f in Fig. 496*a*. Since the line $v_3\ b_3$ in Fig. 499, and the line $v_2\ b_2$ in Fig. 496, represent one and the same edge of the pyramid, the point f_3, which corresponds with the points f_2, and f in Figs. 496 and 496*a*, must be located in the line $v_3\ b_3$. Hence to find the point f_3 in Fig. 499, make $v_3 f_3$ equal to $v\ h$ in Fig. 496*a*. Although the distance between the points v_3 and f_3 in Fig. 499 represents the distance between the points v and f in Fig. 496*a*, we must not make $v_3 f_3$ equal to $v f$, because in Fig. 499 we require the true distance between these points, and, for reasons explained in former problems, the line $v f$ in Fig. 496*a* does not represent the true distance between the points v and f, but it is represented by the line $v\ h$, therefore $v_3\ f_3$ must be made equal to $v\ h$; in this manner the point f_3 is correctly located on the line $v_3\ b_3$. Lastly, in Fig. 496 it will be seen that the cutting plane $e_2\ e_4$ cuts the side $a_2\ b_2$ of the base in the point e_4; it also cuts the side $c_2\ b_2$ in the point e_2. Therefore, in Fig. 499 make $a_3\ e_5$ equal to $a_2\ e_4$ (Fig. 496), and $c_3\ e_3$ equal to $c_2\ e_2$. Join the points f_3 and e_5, also f_3 and e_3 by straight lines, and thus complete the outline of the shaded part in Fig. 499, which is the development of the shaded portion of the pyramid shown in Figs. 496 and 496*a*.

Directions.—In the space marked Prob. 94 draw the development of the shaded portion of the pyramid shown in Figs. 496 and 496*a*. The dimensions of this pyramid will be found in the directions given at the end of Art. 607. Use 3-inch scale.

613. The shaded part in Fig. 500 represents the development of the shaded portion of the pyramid shown in Figs. 497 and 497*a*.

The mode of procedure in finding this development is similar to that in the preceding problem Hence, we first find the development of the whole convex surface of the pyramid which is bounded by the straight lines $v_3\ A_3$, $A_3\ b_3$, $b_3\ c_3$, $c_3\ d_3$, $d_3\ a_3$, and $a_3\ v_3$. The lines $v_3\ A_3$, and $v_3\ a_3$ are represented in Fig. 497 by the line $v_2\ a_2$; the line $v_3\ b_3$ is represented in Fig. 497 by $v_2\ b_2$; $v_3\ c_3$ by $v_2\ c_2$, and $v_3\ d_3$ by $v_2\ d_2$. Make $e_3\ b_3$ in Fig. 500 equal to $e_2\ b_2$ in Fig. 497; and $e_5\ d_3$ equal to $e_4\ d_2$. Also make $v_3 f_3$ in Fig. 500 equal to $v\ f$ in Fig. 497*a*; and $v_3\ g_3$ equal to $v\ h$. Now, remembering that the line $v\ b$ in Fig. 497*a* is the projection of two edges of the pyramid, namely those edges which in Fig. 497 are represented by the lines $v_2\ b_2$ and $v_2\ d_2$, and also remembering that the cutting plane $f\ e$ is perpendicular to the vertical plane of projection, we must make $v_3\ g_5$ in Fig. 500 also equal to $v\ h$ (Fig. 497*a*). Now notice that $v_3\ g_3$ and $v_3\ g_5$ are not made equal to $v\ g$ in Fig. 497*a*, but they are made equal to $v\ h$. We have again drawn attention to this fact, because, in our experience in teaching drawing, we have observed that students are very liable to mistake the foreshortened distance between two points for the true distance. It may also be well to notice here, that $e_3\ b_3$ in Fig. 500 is made equal to $e_2\ b_2$ in Fig. 497, and is not made

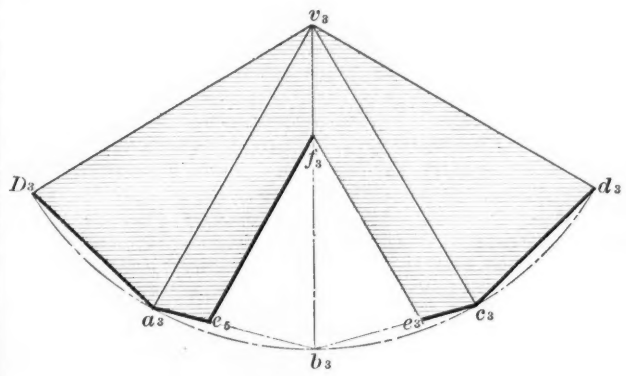


Fig. 499

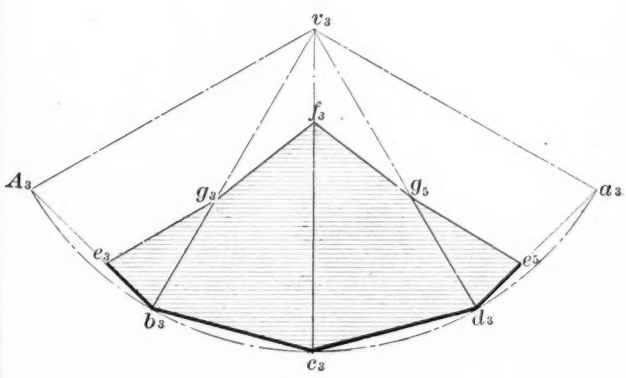


Fig. 500

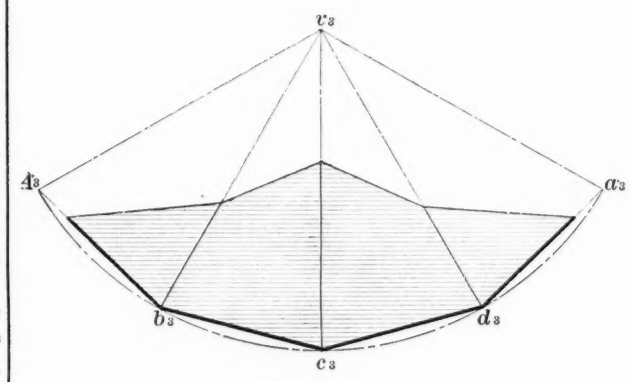


Fig. 501

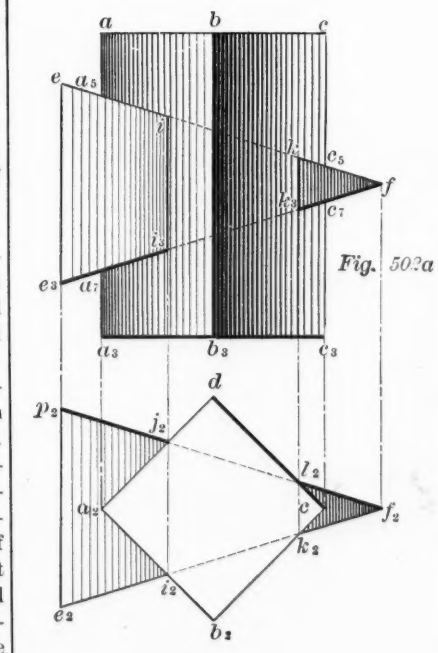


Fig. 502a

Fig. 502

equal to $e\ b$ in Fig. 497*a*, because $e_2\ b_2$ shows the correct distance between the points e_2 and b_2, whereas $e\ b$ in Fig. 497*a* does not show the correct distance between the same points. In Fig. 500, join the points e_3, g_3; g_3, f_3; f_3, g_5; g_5, e_5; and thus complete the outline of the shaded part, which is the development of the shaded portion of the pyramid shown in Figs. 497 and 497*a*.

Directions.—On a separate piece of drawing paper draw full size the development of the shaded portion of the pyramid shown in Figs. 497, 497*a*. The dimensions of the pyramid and position of the cutting plane are given in the directions in Art. 610.

614. The shaded part in Fig. 501 represents the development of the shaded portion of the pyramid shown in Figs. 498 and 498*a*. The manner of finding this development is precisely similar to that of finding the development in the foregoing problem; further explanation is unnecessary.

Directions.—On a separate piece of drawing paper find the development (full size) of the shaded portion of the pyramid shown in Figs. 498 and 498*a*. Dimensions of this pyramid and position of cutting plane are given in the directions in Art. 611.

Problem 95.

615. *Intersection of a prism with a pyramid.*

Let $a\ a_3$, $c\ c_3$, Fig. 502*a*, and $a_2\ b_2\ c\ d$, Fig. 502, be the vertical and horizontal projections of a prism with its lateral faces perpendicular to the horizontal plane of projection, and let $e\ e_3\ f$, and $e_2\ f_2\ p_2$ be the vertical and horizontal projections of a pyramid passed through the prism; it is required to find the intersections of the prism with the pyramid.

The line $e_2 f_2$ (Fig. 502) intersects the line $a_2\ b_2$ in the point i_2; through this point draw a vertical line, cutting $e_3\ f$ (Fig. 502*a*) in the point i_3, also cutting the line $e f$ in the point i; the line $i\ i_3$, joining the points i and i_3, will be the intersection of the lateral face $e\ f\ e_3$ of the pyramid with the lateral face $a\ b\ a_3\ b_3$ of the prism.

Through the point k_2, in which the line $e_2\ f_2$ (Fig. 502) cuts the line $b_2\ c$, draw a vertical line, cutting the line $e_3\ f$ (Fig. 502*a*) in the point k_3, also cutting the line $e\ f$ in the point k. The line $k\ k_3$ will be the intersection of the lateral face $e\ f\ e_3$ of the pyramid with the lateral face $b\ c\ b_3\ c_3$ of the prism.

The principles upon which this simple method for finding the lines of intersection $i\ i_3$ and $k\ k_3$ is based, are as follows:

The triangle $e\ e_3 f$, in Fig. 502*a*, is the vertical projection, and the line $e_2 f$, in Fig. 502, is the horizontal projection of one and the same lateral face of the pyramid; again the rectangle $a\ b\ a_3\ b_3$ is the vertical projection, and the line $a_2\ b_2$ is the horizontal projection of one and the same lateral face of the prism. For the sake of simplicity we may now assume that we have to deal with two planes, namely ($e\ e_3 f$, $e_2 f_2$) and ($a\ b\ a_3\ b_3$, $a_2\ b_2$) intersecting each other, and that the line of intersection is to be found. We know that this intersection must be a straight line, therefore, by finding two points in this line of intersection, the position of this line will be known. Now the lines $e\ f$ and $e_2 f_2$ are the projections of one and the same edge of the pyramid, and this edge intersects the lateral face of the prism in the point i_2, Fig. 502; the vertical projection of this point must lie in the line $e f$ (Fig. 502*a*), and also lie in a vertical line drawn through i_2; hence the point i in which $e f$ and the vertical line through i_2 intersect each other, must be the vertical projection of the point in which the edge $e f$ pierces the lateral face of the prism; hence the point i must be one point in the required line of intersection.

The horizontal projection of the edge $e_3\ f$ coincides with the line $e_2 f_2$; hence we may say that $e_3 f$ and $e_2 f_2$ are the projections of another edge of the pyramid. In Fig. 502 it is seen that this edge also intersects the lateral face of the prism in the point i_2, and the vertical projection of the point in which this edge pierces the lateral face of the prism must lie in the line $e_3 f$, and also in a vertical line drawn through i_2; hence the point i_3, in which $e_3 f$ and a vertical through i intersect each other, must be the point in which this edge pierces the lateral face of the prism. But the edges $e\ f$ and $e_3\ f$ lie in the same plane, consequently the points i and i_3 must be points in the line of intersection, and the straight line joining these points is the line in which the lateral face ($e\ e_3 f$, $e_2 f_2$) of the pyramid intersects the lateral face ($a\ b\ a_3\ b_3$, $a_2\ b_2$) of the prism. Similar reasoning applies to the method for finding the line $k\ k_3$.

In our next paper it will be shown that the lateral face of the pyramid represented by the line $e\ f$ in Fig. 502*a*, and by the triangle $p_2\ e_2 f_2$, in Fig. 502, cuts the lateral face $a\ b\ a_3\ b_3$ of the prism in a line coinciding with the line $a_5\ i$; and also cuts the lateral face $b\ c\ b_3\ c_3$ in a line coinciding with $k\ e_5$. And lastly: The lateral face of the pyramid represented by the line $e_3 f$, in Fig. 502*a*, and by the triangle $p_2\ e_2 f_2$, in Fig. 502, cuts the lateral face $a\ b\ a_3\ b_3$ of the prism in a line coinciding with the line $a_7\ i_3$, and also cuts the lateral face $b\ c\ b_3\ c_3$ in a line coinciding with the line $k_3\ c_7$.

Force in the Steam Engine and Its Relation to Smooth Running.

BY PROF. JOSEPH TORREY.

THIRTEENTH PAPER.

At the outset of our study of the action of the connecting rod—which must necessarily be an incomplete one at present—we must get clearly in mind the bearing of our results. It is a common thing to hear the rod spoken of as being "all reciprocating and partly centrifugal," and its weight is usually added to that of the crosshead piston and rod for inertia calculations, as if it furnished the same force in amount and distribution as though the motion of the connecting rod were of the same nature as that of the other reciprocating parts. At the same time, most engineers have, like Prof. Sweet, "an instinctive feeling" that a certain weight in the crosshead of an engine has a different effect in modifying pressures on the pin from what the same weight would have if concentrated at the pin or placed anywhere in the rod.

Nothing can be clearer than that the small end of the rod has a purely reciprocating motion, and the remainder a mixed motion. We shall find in the course of our study that by the whole rod there is the same *amount* of reciprocating action as if the rod had no circular motion, but the *distribution* of this action throughout the stroke will be different.

In order to show this, I give below a table showing the action of a weight of 100 lbs., first considered as in the crosshead, the rod being conceived as without weight, and then as all concentrated at the pin, the other parts being without weight. Fig. 1 (page 5) shows the curves given by these forces, applied to an indicate diagram. The dotted line shows the curve given by the mass at the pin and the full line that given by the mass in the crosshead, and the effect on the diagram of real effort on the crank-pin is not insignificant by any means. The curves cross the neutral line at the same point, and the main difference between them is that the curve of forces given by the revolving mass is equidistant from the neutral line at the back and front end, while the regular inertia curve is further away at the back end than at the front end.

In this case we have put the *whole weight in the pin* because whatever part of the rod is found to be "centrifugal in effect," acts very nearly as it would if it were concentrated at the pin, and, consequently, will exert a differently distributed action from what it would if moving with the crosshead. A clear understanding of this fact will show

the necessity for a pretty close analysis of the rod's motion.

I will now give a method of determining the proportion of the weight of any connecting rod which acts centrifugally. It is substantially the method given by Mr. J. C. Hoadley in the article referred to in the twelfth paper, but I shall follow the matter down a

Table Showing Effect of 100 Lbs. in Crosshead and Large End of Rod.

Ordinate.	100 lbs. in Crosshead.	100 lbs. in Con. Rod.	Ordinate.	Centrifugal Force along Con. Rod.
0	57.36	48.86	0	1.000
1	49.19	42.75	1	0.875
2	36.18	31.02	2	0.635
3	23.43	21.00	3	0.430
4	11.87	9.52	4	0.210
5	0 72	0 48	5	0.010
6	10.59	9.01	6	0.185
7	19.42	18.16	7	0 375
8	27.43	27.85	8	0.570
9	34.26	36.40	9	0.745
10	39.72	44.70	10	0 915
0	41.78	48.86	0	1.000

little closer, and, since conditions will be different according as the rod is uniform or tapering, I shall consider both cases.

In Fig. 2 is shown a connecting rod, with body of uniform section. We shall first divide it into parts, estimate the weight of each part, and then see how much of this weight is centrifugal in effect, *i. e.*, must be considered as concentrated at the crank-pin. In this case we divide, first, the body of the rod, beginning at the strap at the small end, into four equal parts. The weight of each of these parts must now be estimated, and also that of the large and small ends. Considering the rod to be for a 10″x12″ engine at 300 revolutions, the body of the rod may be 1″x2¼″ in section, and since each of the parts into which the body was divided was equal to the length of crank, 6″, the cubic contents of each division will be $6 \times 2\frac{1}{4} \times 1 = 13\frac{1}{2}$ cubic inches. A cubic inch of hammered steel weighs about .2834 lbs., therefore the weight of each division will be $13.5 \times .2834 = 3.82+$ lbs. The large end of the rod, if solid, would contain about $7 \times 2 \times 5 = 70$ cubic inches. From this we must subtract the volume occupied by the brasses, which, including space occupied by the crank-pin, would be about $3\frac{1}{2} \times 4\frac{1}{2} \times 2 = 31.5$ cubic inches. The crank-pin may be 3″ in diameter, and its volume will be $7.068 \times 2 = 14.13$ cubic inches. This leaves for the actual volume of the brasses $31.5 - 14.13 = 17.37$. We now subtract the volume of the brasses, including the pin, from the volume of the large end, and have $70 - 31.5 = 38.5$ cubic inches as the volume of that part of the large end, which is steel. The weight will be $.2834 \times 38.5 = 10.9$ lbs. The brasses, without the pin, have a volume of 17.37 cubic inches. A cubic inch of such brass as is ordinarily used weighs 0.3 lb. per cubic inch; hence the weight of brasses will be $17.37 \times 0.3 = 5.21$ lbs. The small end of the rod comes next, and to save space we will assume that its weight is three-quarters that of the large end, or say, 12 lbs. Adding up these results we have the following:

Large end, including brasses,	=	16.11 lbs.
4½ divisions of body each 3.82	=	15.28 lbs.
Small end, including brasses,	=	12.00 lbs.
Total.....		43.39 lbs.

I believe these proportions are fairly good, and it will be seen that the large end of the rod constitutes 37 per cent. of the weight of the whole rod, or more than one-third. Rods are not uncommon in which the large end weighs nearly one-third as much as the whole reciprocating mass. It seems from this that considerably more than one-third of the rod will prove to have centrifugal effect.

Before analyzing the weight of a tapering rod, we will consider the motion of different parts of the rod under consideration.

Suppose the weight of each of the divisions of the rod we made to be concentrated at its center of gravity. At the small end we will suppose the center of gravity is in the crosshead pin, which will involve no error of any consequence. The divisions of the body are all equal and uniform, so their centers of gravity will be at the centers of the divisions. In case of the large end the center of weight will be about at the inner edge of the brass. A small circle is drawn at the center of gravity of each division. Next we want to find the paths described by each of these little circles, which are supposed to represent the points at which the weight acts. Fig. 3 shows these paths. The horizontal line *A C* represents the path of the small end which moves along the guides. Next take point 1 (Fig. 2). When the piston is at half stroke the rod will have the position *A′ C′* (Fig. 3). Point 1 in Fig. 2 will have the position *a′* Fig. 3. At the end of the stroke point 1 will have the position *a″*. At half stroke backwards it will be at *a‴*, and at the back end it will again return to *a*, having described not a straight line or a circular path, but an elliptical one. In the same way point 2 will describe the ellipse *bb′ b″ b‴*, and point 3 will describe the ellipse *c c′ c″ c‴*. The center of gravity of the large end will describe a path so nearly circular that we can consider it as such without sensible error. It is evident that the small end has no centrifugal action whatever, and that the large end, since it moves in a circle, exerts the same amount of centrifugal force horizontally as vertically. The intermediate parts act centrifugally just in proportion to the distance they travel from the line of centers. Now the distance any point in the rod travels from the line of centers depends on its distance from the crosshead pin, as a little reflection will show; consequently the centrifugal action of each division will depend on the distance of its center of gravity from the center of the crosshead pin. Accordingly we measure the distance of points 1, 2, 3, and 4 from the center of crosshead pin in Fig. 2, calling length of rod 100 for convenience, and we have

Distance 0.1	=	$\frac{21}{100}$ (nearly)
" 1.2	=	$\frac{38}{100}$ "
" 2.3	=	$\frac{55}{100}$ "
" 3.4	=	$\frac{71}{100}$ "
" 4.5	=	$\frac{96}{100}$

From this it would appear that $\frac{21}{100}$ of the weight of division 1, or about 1-5, was centrifugal. In the same way, $\frac{38}{100}$ of division 2, $\frac{55}{100}$ of division 3, $\frac{71}{100}$ of division 5, and $\frac{96}{100}$ of division 6 are centrifugal in effect. But what we want is to find how much of the weight of each division can be regarded as concentrated at the pin. It is perfectly clear that if a certain weight were placed first in the crank-pin, and then at point 1, it would give more vertical centrifugal force at the pin than when revolving in the small flat ellipse. Now from geometry we know that the heights of the ellipses in Fig. 3 are proportional to the distances of their centers from the crosshead pin. Then the height of the ellipse generated by point 1 is $\frac{21}{100}$ of the height of the circle generated by the crank-pin. That is, a body at the point 1 only travels $\frac{21}{100}$ as far from the line of centers as a body at the crank-pin does.

Now if this is so, a body revolving at the pin would generate about five times as much centrifugal force vertically as if it were at point 1. So that to give a certain centrifugal force a body would only have to be about 1-5 as heavy at the crank-pin as if it were at point 1; but we found that $\frac{21}{100}$ of division 1 was centrifugal; but if we wish to represent this as concentrated at the pin, we must take $\frac{21}{100}$ of this $\frac{21}{100}$, because this would give the same vertical centrifugal effect. In the same way division 2 has $\frac{38}{100}$ of its weight centrifugal, and to give the same effect at the pin the weight would only need to be $\frac{38}{100}$ as great; hence the portion of division 2, which may be considered as concentrated at the crank-pin, and revolving with it, is $\frac{38}{100}$ of $\frac{38}{100}$. Division 3 has $\frac{55}{100}$ of its weight centrifugal, and to give the same effect at the pin the weight need only be $\frac{55}{100}$ of this; hence proportion of centrifugally acting weight in this case is $\frac{55}{100}$ of $\frac{55}{100}$. In the same way each of the other points, or any number can be treated, and, of course, the more points are taken the more accurate will be the result. I believe five or six points give close enough results, however. Tabulating the results obtained, we have the following weights acting at the pin centrifugally.

Division 1	.21 × .21 × 3.82 lbs.	= 0.168 lbs.
" 2	.38 × .38 × 3.82 lbs.	= 0.55 lbs.
" 3	.55 × .55 × 3.82 lbs.	= 1.153 lbs.
" 4	.71 × .71 × 3.82 lbs.	= 1.925 lbs.
" 5	.96 × .96 × 18.02 lbs. (=large end + ½ a division of body)	= 16.59 lbs.
Total.....		19.386 lbs.

This is equal to nearly 45 per cent. of the whole rod. The case of the tapering rod will be considered next time.

The right hand division of the table shows the proportion of the weight revolving at the crank-pin which is exerted along the connecting rod, the whole centrifugal force generated being taken as 1.

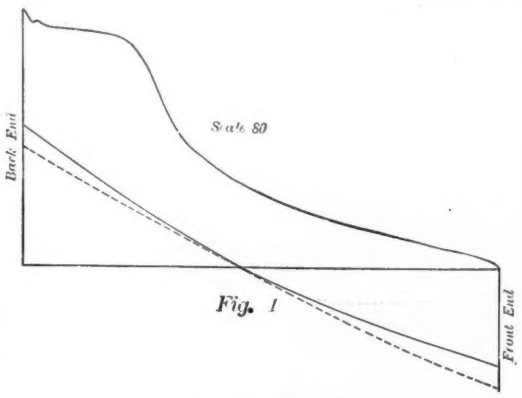


Fig. 1

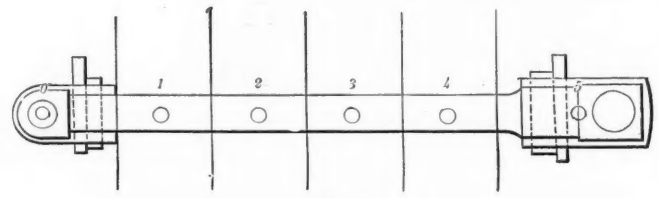


Fig. 2

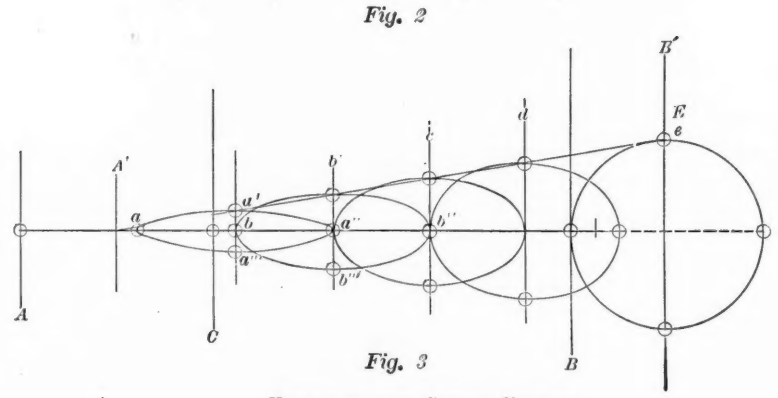
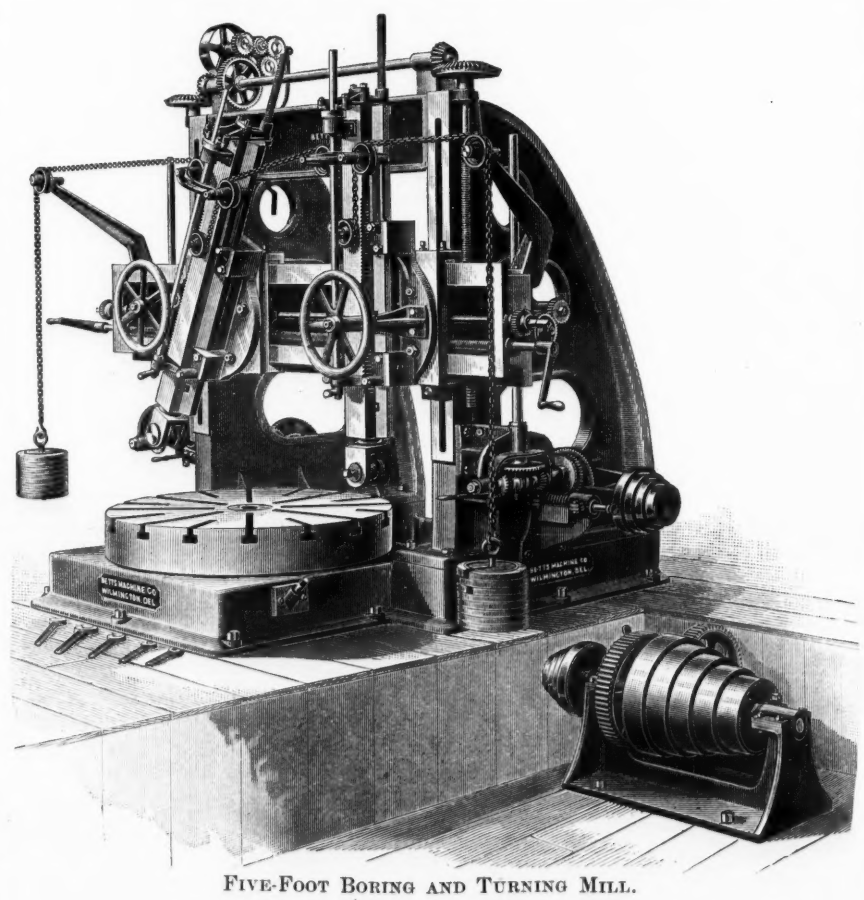


Fig. 3

Force in the Steam Engine.



Five-Foot Boring and Turning Mill.

Five-Foot Boring and Turning Mill.

The accompanying illustration represents a 5-foot boring and turning mill, recently built by the Betts Machine Co., of Wilmington, Del. In general construction it is similar to other tools of this class by this company, but with improvements in the method of counterbalancing the tool spindles, and application of the feeds to the same. By means of two weighs on the same chain, both tool spindles are fully counterbalanced, which is an impossibility with any system using only one weight.

The feeding device is so arranged that it requires no attention when raising or lowering the cross-rail, and can be reversed or thrown out altogether by movement of a single lever.

The cross-rail is provided with two saddles, one of which will cut to the center of the table or face plate; each saddle is provided with a graduated index plate carrying the tool spindles. The tool spindles can be fed in any direction, and the saddles back or forth by power; each saddle and tool spindle is provided with separate and independent feeds, so that while one tool is roughing out one part the other can be taking a finishing cut on another or the same part; in fact, the feeds are as entirely independent as though they were on separate machines.

The table, or face-plate, is four feet in diameter, and is driven by a steel pinion, gearing into an internal spur wheel cut on the inner edge of the table, which effectually prevents any raising of the same. The entire train of driving gears is cut from the solid, and is of ample proportions.

The driving cone is of large diameter for a 3¼-inch belt, and can be driven at two sets of

speeds by means of a properly arranged countershaft.

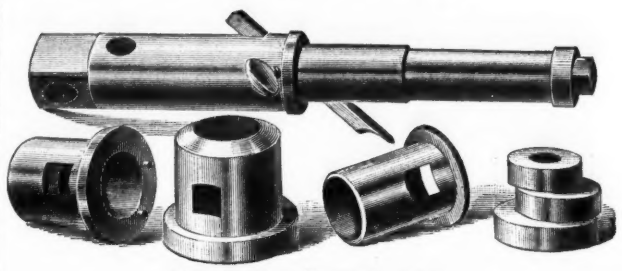
There are 20 speeds to the table, and each saddle has 12 feeds. The tool spindles have 24 inches travel, and are provided with quick movement by hand; they are of box form, and have taper holes bored truly central with the table, so that either boring bars or the tool-holders furnished can be used.

The table is provided with a long spindle running on hardened steel step, and has bearings, top and bottom, ensuring steady running; when used on heavy work the step is lowered, and the table rests on an annular bearing of large wearing surface.

The machine is simple in construction and designed to stand all the requirements of modern practice.

The Vance Flue Cutter.

The engraving represents improvements in this cutter, which is made by the Vance Tube Cutter Co., Geneva, N. Y. This cutter is designed for use in removing all flues from boilers. The mandrel, as shown in the cut, is for removing two-inch flues, the same being placed in the flue with the slot up. The knife is then inserted with bevel down and point of same driven through the flue; a bar or wrench is then used on the end of mandrel, and one revolution makes a complete and perfect cut, leaving the end of flue all ready for scarfing. In cutting the flue the knife serves to contract the end and the flue can be removed through the hole in the flue sheet without trouble. The cutters are made with adjustable sleeves, so that one cutter will operate on four sizes of flues, all that is necessary to make the change for different sizes being to take the roller off the end of mandrel and replace with sleeve and roller to correspond with the size of flue it is desired to operate on.



THE VANCE FLUE CUTTER.

LETTERS FROM PRACTICAL MEN.

That 16-inch Lathe—Sketching at Expositions—The Cockerill Engine Casting.

Editor American Machinist:

It is a consolation to me to know that such a man as Mr. Fay (who is evidently a lathe man, and one who reasons about things,) has taken the trouble to examine the subject understandingly and tell unhesitatingly what he thinks about the 16-inch lathe. I believe some good may come from arguing the different points, and without claiming that the lathe is right, or half right, or good or bad. I wish to show Mr. Fay, if I can, that his arguments on some of the points are untenable.

First as regards the support for the boring tool. In an ordinary slide rest the average length of the front and back slides is, we will say, 18″, with the cross slide 4″ wide. With such a slide the tool can project 7″ from the tool post before it will be even with the ends. In my lathe, the front projects 15½″ and the back none, so that the tool can project 7¾″ before reaching the unsupported point when boring the smallest hole, and more as the hole grows larger, as shown in Figs. 1 and 2.

Another point that comes is in the twisting of the cross-beam. In my lathe the entire apron is cast in the same piece, making the front connection the strongest possible, and, as the back slide is gibbed down under a square ledge, twist is no more possible at the back than if the cross-bar was attached to the center of the back—if the back slide was but 18″. I do not believe the lathe is half strong enough in this respect, nor are any American lathes—but I supposed this was as good or better than the majority.

The second point: The screw is low down, it is true, but just as near the sliding surface as was possible, and as the slide is 3 feet instead of 18 inches, the proportion for stability is much better. (See Figs. 3 and 4.) Besides, I suppose the work is more in turning than in screw cutting, and as the rack is between the slide and work, this is immensely better than if the sliding surface was above the rack. If I am mistaken in this, I think it must be in supposing that it requires more power to travel the slide in heavy turning than in screw cutting.

It is a good deal more than probable that a taper attachment is a better device for boring and turning tapers than turning the lathe heads—but this, where no taper attachment is at hand, is better than nothing, for when a man wants such a thing, there are times when he wants it badly. If he had a large number of taper holes to bore or grind, the swinging head stock is the better plan. When the taper attachment gets worn so as to have tight and easy fits, as does come in time, it is not as reliable as the slide rest for true work. But on the whole the taper attachment is the better of the two.

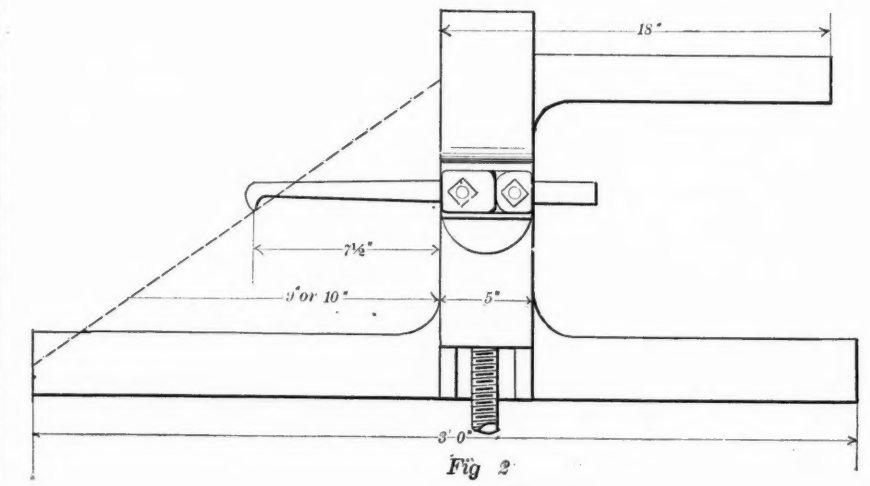


Fig 2

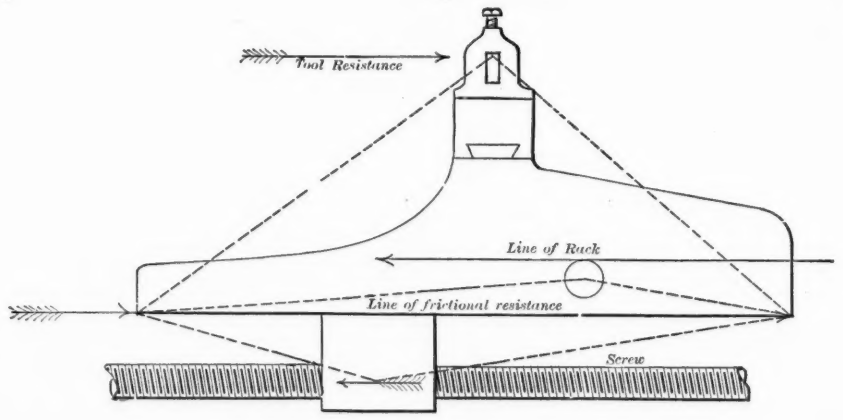


Fig. 4

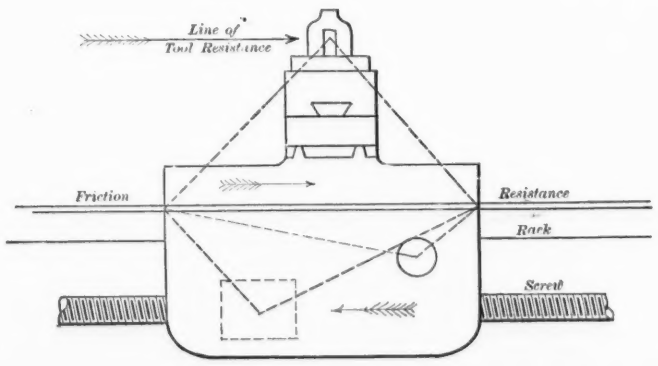


Fig. 3 16-INCH LATHE.

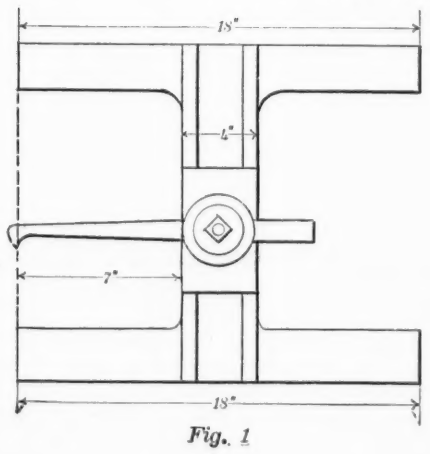


Fig. 1

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As regards the double cone for gripping the foot stock spindle: The three or four lathes built at Cornell University, and among them the one exhibited at the Centennial, all had exactly the same arrangement as Mr. Fay describes, but I could see no reason why the two cones could not be fitted so as to both grip, if on one sleeve, nor why they should wear unequally; in fact, why, if they did not bear equally at first, they should not wear until they did. One difficulty arose in using the two cones on separate pieces. Both would be drawn in with equal force, provided the nut was not confined between the shoulders, but then, if it was not pretty accurately fitted, it would drive out *one* of the cones and leave the other sticking fast. Good work avoided the trouble, but the plan adopted seemed the cheaper.

While I am in the defensive mood, I wish to argue one or two of the statements that also appear in the AMERICAN MACHINIST for August 1st. You call attention to the fact that it is against the rules to make sketches at the Paris Exposition. I believe this has been the rule at all universal exhibitions—at Philadelphia as well as elsewhere. Very likely no American was interfered with at the Centennial; they were not likely to be; but if foreigners were not, it was probably because they had sense enough not to try it, and it is hard for the American to realize that he is a foreigner in France. At the exhibition in London in '62 I was stopped from sketching a bird I had never seen before—one of the kind that has legs like a two-foot rule, which they can double up and stick under their wings, as a carpenter doubles up his rule to put it in his pocket.

Your editorial correspondent mentions the "Cockerill" casting as valueless, and simply made to show what can be done. I do not believe this at all, but believe it no more of an exaggeration over and above their every-day work than the rest of us have done. We have all done the best we could of the kind of work we do—and I certainly cannot see why their way of making that kind of an engine is not the best possible way. There is nothing about it to wear out, as the cylinder and valve chests have bushings, the boxes and slides separate pieces, and certainly there can nothing shake loose. Will it cost any more to bolt the parts together in the sand than in the shop? The danger of losing the casting in the foundry is the bugbear with many, while, as a matter of fact, the percentage of wasters in the foundry is as great on the simple as on the difficult pieces; and if the loss is 5 per cent. it is just as costly if the pieces are simple as if complicated.

JOHN E. SWEET.

[I never like even to appear to disagree from our present correspondent, because of the habit he has of being right. There was, however, more than one reason why I called the casting exhibited by the Society Cockerill (AMERICAN MACHINIST, August 1st,) "valueless except" (the except is worthy of notice.) One reason was that I do not believe it is, in the present state of the art of moulding and casting, practicable to make such castings. There is, in the best regulated foundry, a certain percentage of loss—"wasters," as the English put it. If we are to make a hundred castings in which the loss is—let us say five per cent.—it appears to me that the total loss to the foundry will be materially greater if we contrive to connect them together so that a failure in one will condemn the whole. This loss may or may not be compensated by less cost in moulding. In the case of the Cockerill casting I do not believe it would be. In fact, I think the cost of moulding all the parts together will largely increase the cost, taking the work in the machine shop into consideration.

Still perhaps I was more influenced in my belief by a legend attached to the exhibit, to the effect (I regret that I did not copy it), that the casting was exhibited to show what could be done rather than what ought to be done.

I am of the opinion that the Society Cockerill do not make triple expansion engines that way, although I do not doubt that they could do so.

I might remark that any of the various parts of a triple expansion engine are liable to accident, but I do not press that point. I am quite as willing to admit the excellence of the "every-day work" of the Society Cockerill as Professor Sweet is.—H.]

About Lathe Centers.

Editor American Machinist:

I have read the communication of Mr. Chappell, and now wish to give in my testimony in favor of the article to which he refers in your issue of August 1st, page 8. After thirty years' experience as machinist, I am convinced that the angle of the American lathe center is a proper one for all kinds of work, light or heavy. I can see no reason why the *angle* should be changed. The only change I would make is to blunt the point for heavy work, say for car axles—of which I have turned and fitted thousands—to about a quarter of an inch diameter, to prevent its being broken off. And, furthermore, I would drill and countersink all work to be turned. Countersinking *only* is a case of main strength and stupidity. Perhaps I am too "fine-haired."

J. E. SCRIBNER.

Size of Gear Blanks and Cutters.

Editor American Machinist:

In the June 20 issue, under "Questions and Answers," the question is asked how many teeth in gear 2½″ pitch diameter 12 per inch cut spiral at an angle of 45°. Whether the gear is spur or spiral makes no difference in diameter of gear. Twelve per inch diametral pitch means that for each inch of pitch diameter there will be 12 teeth on periphery. But a cutter made for spur gear of 30 teeth

12 per inch, is not correct for a spiral gear of 30 teeth, 12 per inch. The circular pitch corresponding to 12 per inch = .2618″ in all cases, and thickness of tooth on pitch line = .1309″ in all cases, and a cutter for spur gear 12 per inch should be .1309″ on pitch line. In a spiral gear, to ascertain thickness of cutter, divide the above thickness by the secant of the angle, which in 45°=1.4142, and we get .09256″ for thickness of cutter on pitch line, and the space cut by this thickness of cutter will, when measured, be parallel to sides of gear = .1309″. A. S. ALDEN.

[The above is all true enough, but not inconsistent with our answer.]

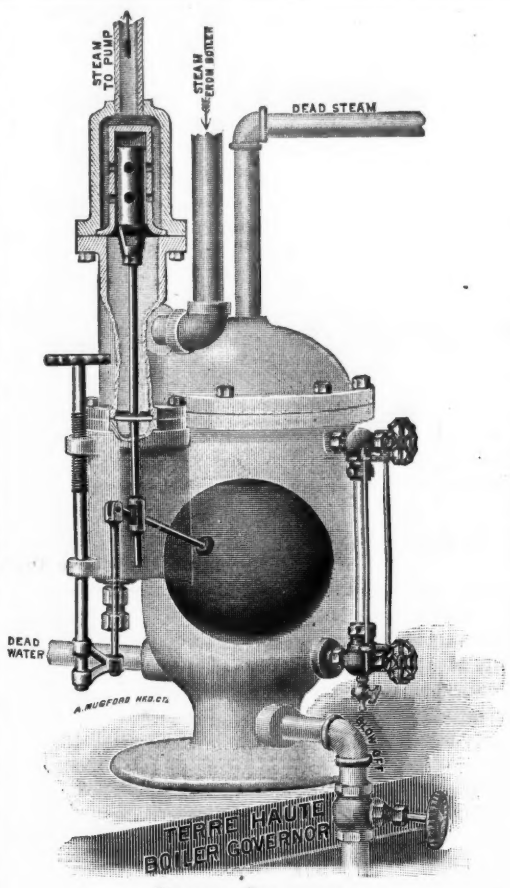
The Terre Haute Boiler Governor.

The engraving herewith represents a boiler feed governor made by the Terre Haute Boiler Governor Company, Terre Haute, Ind. The governor, which is twenty-four inches in length and eighteen inches in diameter, is placed between the pump and boiler, and is connected with the boiler above by the dead steam pipe, and below with the dead water pipe, the same as a water column. By this means the water in the governor is held at the same level as the water in the boilers.

The copper float rides on the water in the case of the governor, and is furnished with a lever that connects with the stem that is attached to the valve, so that a variation of the water, up or down, opens or closes the openings of the valve, and by this opening or closing of the valve regulates the supply of steam to the pump. The machine can be attached to either end of the boiler, or boilers, whichever is the most convenient.

The valve—which is a balance valve—is provided with openings through which the steam passes to the pump, and opens and closes with the rise and fall of the water.

The hand-wheel and screw which are shown in cut are used to open and close the valve, which regulates the height of the water in the boiler. When the float is set at the proper height it needs no more attention. The action of the governor is said to be so sensitive that the height of the water in the boiler does not vary enough to be perceptible.



BOILER GOVERNOR.

Reservoirs.

BY ROBERT E. MASTERS.

There are a variety of ways to pour from an air furnace for heavy work; in some cases a large ladle alone is used. Where enough iron cannot be obtained at one time in the air furnace, the cupolas are operated in conjunction with the air furnace, the iron being carried from the cupolas in crane ladles to the reservoir.

Sometimes the iron is tapped from the air furnace and run through troughs direct to the mould without the use of ladle or reservoir, arrangements being made to turn the iron in some other direction when the mould is full. In a case of this kind there are basins in the trough, with well-rodded cores fastened across them, that act as a backstop to the iron, the clean iron flowing to the mould underneath the core, which makes a dam and skims the iron.

Frequently as soon as the iron is in condition it is all tapped into a large reservoir, which is connected with the air furnace with troughs; it is then tapped from the reservoir and run through troughs to the mould. This does very well for some work, but there are exceptionally heavy castings made that would take an extraordinary large reservoir to hold all the iron at one time, and which would require as much or more room than the mould, and take a large amount of labor to handle and prepare it.

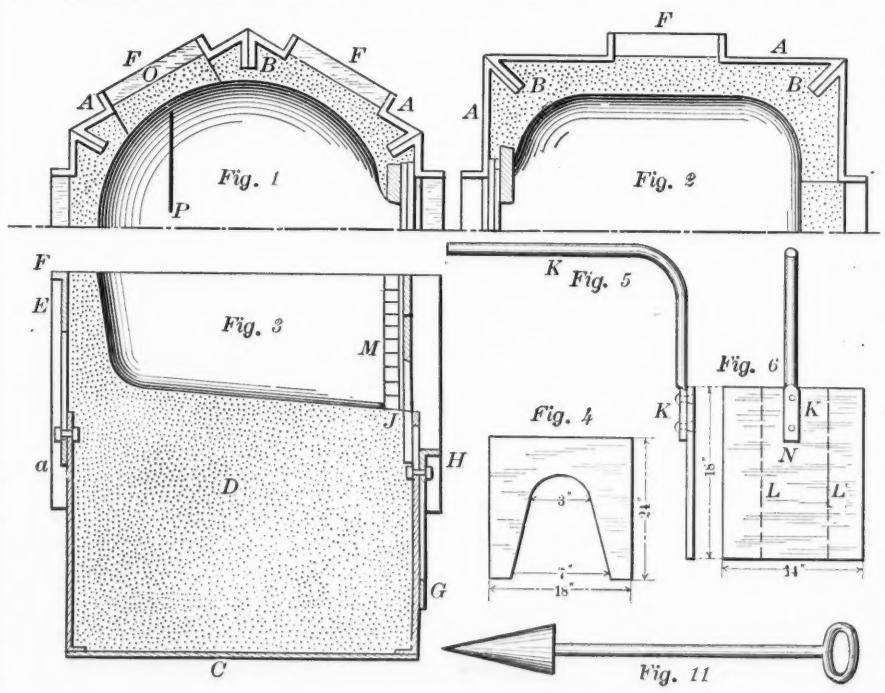
The drawings show an arrangement of reservoirs or receivers, troughs, etc., that are in a foundry in connection with a large air furnace, and ofttimes it has been used to receive the iron from large double air furnaces.

Figs. 1 and 2 are plans (showing one-half) of hexagon and square reservoirs. Fig. 3 is a vertical section of same; they are both constructed on the same principle, but as Fig. 1 is best adapted for a double air furnace, and answers equally as well as Fig. 2 for a single air furnace, I will confine the description chiefly to it.

The sides *A* are cast-iron sections bolted together inside at *B*. There is an opening in the upper part of each of these sections 12″ wide and 18″ deep, measuring from top edge of plate; there is a flange on the edge of and extending below the openings as a guide for an adjustable cast-iron plate. This plate has a slot nearly the whole length of it, and a flange on the upper edge of the plate. It can be raised and lowered to shut off the opening, being held fast with a bolt through the slot in the slide, and a hole in the section below the opening.

This reservoir is 5 feet in diameter and 4 feet deep; it is bolted to the bottom plate *C*, and put in position on the floor. Sometimes the bottom plate is dispensed with altogether. If the reservoir is too high for the work it can be let into the floor. The bottom is rammed full of sand, and a cinder bed *D* put in, and the bottom and sides rammed up. Each of the cast-iron sections has a number of small holes for the escape of the gas. For any of the openings that are not to be used the slide is raised to the top, and bolted fast to bank, as at *E*, or they can be left down low enough to let in the troughs from the air furnace, which rest on and are secured to flanges *F*. The slide at the opening through which the iron flows to the mould is down at *G*, and the troughs can be fastened on the flange and between the guides at *H*.

In building the basin, the fork, Fig. 4, is placed on the inside, across and firmly against the sides of the opening, the points extending into and bedded in the sand at *J*. The shutter, side and front view, Figs. 5 and 6, which has a wrought-iron bar handle, *K*, riveted to it, is placed with the smooth side against the fork, the bottom edge making an impression in the sand. This closes up the opening in the fork, then finish to build up the sand wall of the reservoir. Sometimes sand alone is used to back up the shutter on each side as far as the dotted lines *L L*, but it is not a good plan, as this shutter has to be slid up or down to suit the supply of iron when pouring the mould, and it is safer to have fire-brick built in the sand wall at *M* on each side of the shutter as far as the dotted lines *L*. This leaves the space *N* between the brick free for the iron to lay against. The shutter is carefully clay-washed and blacked; it and the fork are of heavy boiler iron. The troughs in plan and side view, Figs. 7 and 8, are used from the furnace to the reservoir. If two air furnaces are in operation one trough enters at *O* and the other at the opening parallel with the line *P*; if only one furnace is in use it can enter at the side or back, whichever is most suitable. These troughs are also used from reservoir to the mould, the one shown in two views, Figs. 9 and 10, being used on the end next the mould.



In putting the troughs together the end *Q* is slid down into the grooves of another at *R*, and as it fits down into *S*, the inside of the bottoms are level. With a truss put under at *S* to support them, they cannot come apart. The hole *T* can be used for the iron to run through by stopping off the side or front opening *V* with plates, or a plate can be laid over *T* and the iron run out of the end opening *V* if preferred. The reservoir is covered over with heavy plates, and the plates well covered with sand, a watch hole being left to see how the iron stands in the reservoir. After tapping out the air furnaces and the reservoir is about full, the shutter, Fig. 5, is raised by handle *K*, and as large a stream let run as required, and if it runs faster than the mould will take, the shutter can be lowered to suit; then, if the iron is coming into the reservoir too fast, at a signal from the man on watch the cast-iron plugs on the end of the wrought bar, Fig. 11, can be shoved into and held in the tapping hole enough to cut the supply down to suit. These plugs are cast on the bar; they are from 12″ to 14″ long, and are about 4″ diameter at the largest point. The plug and bar are from 8 feet to 10 feet long over all.

A fork can be put in one of the openings not in use, and arrangements made to tap out any over iron and carry it off for other work, or it can be run into pig beds from this opening, or from an L pipe.

A very curious paper has been found in the archives of the Nurnberg-Further Railway, the first railway constructed in Germany. It is the official opinion of the Bavarian High Medical Collegium, concerning the probable effect of the general introduction of railway travel upon the health of Bavarian subjects. The rapidity of the new transit would, according to the learned doctors, certainly cause a brain disease which would eventually develop into delirium furiosum. Of course, every one who wished to expose himself to this consequence of the new mode of travel might be allowed to do so undisturbed by the State. Other persons, however, should be protected from the perils attendant upon the rapid locomotion. Spectators by the wayside would be liable to brain trouble after merely watching the passing steam cars. Therefore, the railway and cars should be concealed from view by close board fences at least five yards high. All things considered, a still better way of protecting the subjects of the Bavarian crown would be, to forbid altogether the construction of the railway. This opinion was given in 1835 in response to a Government inquiry.

Mr. D. Walter Brown, in a letter published in the *New York Tribune*, calls attention to a recent decision by Assistant Commissioner Fisher, of the Patent Office, which is of considerable importance to inventors and others interested in patents. This decision confirms the right of an inventor to protect by his several claims in a single patent, a machine, a process, and a product where they are related—the one depending upon the other. This is a principle which at one time was clearly recognized by the Department, but recently the tendency has been to require the taking out of separate patents—one for the machine, one for the process, and a third for the product of the machine.

The recent decision that one patent is sufficient to cover all three, is in accordance with common sense and justice, and will tend to do away with needless expense to inventors, and useless complications.

There is some kind of a law in New York City that calls for fire-escapes in tenement houses. A recent fire in one of these houses resulted in the loss of something like ten lives. The fire-escapes were simply death-traps. Would not it be a good idea if the law in respect to fire-escapes was enforced?

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NEW YORK, AUGUST 29, 1889.

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The 1892 Fair.

The work of letting loose the power that is to put in operation the machinery in the World's Fair of 1892 has fairly begun by an organization of the forces that are to make the necessary preparations. An inspection of the names of the men who are to do the work of getting ready for the fair will, we think, convince everybody that Mayor Grant has exercised rare judgment in their selection. It will convince every one that the mayor has followed, as far as possible, the will of the people and the dictates of common sense in the matter, and that he is in dead earnest working for the interests of the exhibition without reference to favoritism. It would not be necessary to refer to this, were it not for the fact that favoritism has frequently a good deal to do with such things. We believe the appointments made by the mayor will give universal satisfaction, and this starts the whole business of preparation on a substantial basis.

But the real work of getting ready for the fair has not begun. There is a vast amount of getting ready to be done, and the slowness with which large bodies move has long since passed into proverb. Conflicting interests—for there will be conflicting interests—must be reconciled, and harmonious action must be brought about. But here the excellent character of the men placed at the head of affairs will materially assist.

The work of planning and constructing the necessary buildings is one of large magnitude. Selecting a proper site is an important matter; it must not only be selected with reference to ample space, but, what is of equal importance, with reference to getting to and from with comfort. It will not do to leave the matter of transit to interested companies, who will, and ought to, perhaps, look only to their own interests in ready coming dollars and cents. Taking into account all that is to be done, there is no time to lose—and this fact cannot be too fully emphasized—if delay at the end is to be avoided.

Granted the necessary buildings are in readiness at the appointed time, that the work of the finance committee is properly done, and all the details properly attended to, there is still to be considered the great work that manufacturers are to do in making the 1892 fair a success. In Machinery Hall, at Paris, a large proportion of the entire space is taken by French exhibitors. A very small proportion indeed is taken by American manufacturers. This will be reversed at New York. American manufacturers of machinery must fill the greater part of the space. We have no doubt that, if properly approached in the matter, they will do so.

But it is also of advantage that foreign countries should be well represented. The great advantage of such an exhibition is in its educational feature, and not what comes from it as an advertising scheme. In fact, this last named consideration should never be considered.

By proper effort—and here, again, is work for the mayor's committees—the number of foreign exhibitors can be multiplied. Such exhibitors ought to be encouraged in every legitimate manner. There ought to be nothing in the line of "narrow gauge" about the 1892 fair. If foreigners can show something better than we have, they ought to be afforded every facility for doing so. In the industrial operations of the world we are competing against a force that is quite underrated. It would be an excellent thing to give every American that attends the fair of 1892 an opportunity to see just what we have to contend with. If we learn that we do not know it all, the fair will not have been held in vain. On the other hand, if Europeans learn that we know how to do a good many things better than they do, advantage will result.

There is little time in which to get ready for a great fair, and we cannot afford to have anything less than this. As one world's fair succeeds another, the effort is always to make the latest better than the preceding one. By and by the limit will be reached. It will not be practicable to go further. But it ought not be reached in 1892. The New York fair ought to be made, and can be made, the greatest of all world's fairs. But it requires a great effort to make it so.

Too Much Persuasion.

Some Western and Southern towns have come to grief more or less intense, through too great efforts to boom themselves as manufacturing centers. In manufacturing, as in everything else, the natural law of location cannot be ignored without disastrous results. It is a fact that in nine cases out of ten, where these inordinate efforts are made to locate manufacturers, land speculation is rife. Where this is the case wise manufacturers will keep aloof, and those citizens not directly interested in booming real estate are not interested at all.

The kind of manufacturers that it is a lasting object to secure are not influenced to any great extent by bonuses. If they are looking for a change of location it is with a view to reducing the cost of manufacture, mainly with reference to getting their raw material, and getting their product to market. A few thousand dollars thrown out as a sop, has, as it should have, but little influence.

But in manufacture, as in other things, there are adventurers who will always be looking for the best thing, and there will be more honest, but misguided men, who will get caught by strong representations which they do not stop properly to consider.

Take the land speculation part of the business of a good many of these new El Dorados. A combine buy up tracts of land that it would appear were desirable for manufacturing purposes. Then, to start the boom, they will give enough to one or two manufacturers to put up shops on. If the boom succeeds, and these same manufacturers desire, in a few years, to increase their plant, they will find that they must pay exorbitantly for ground upon which to build. If this is not the case they are pretty sure to find their location undesirable, and when the prop goes from the land gambling operation they will pay dearly for the privileges they have enjoyed. These places where cities are staked out on the sand, and projected in the air, are good places for manufacturers to shun. Land speculation puts value on paper and nowhere else.

The earth under the pavements of the principal streets of New York city is thoroughly impregnated with gas that escapes from leaky mains. This gas finds its way into the manholes of subways and sometimes into sewers, in sufficient quantities to cause serious explosions. To prevent this it has, to some extent, been the practice to force air into the manholes and sewers before permitting any one to enter them with a light. But it is also believed that electric wires sometimes explode the gas, and that other causes not clearly defined operate to the same end. Now the recommendation is to increase facilities for forcing in air, and so go on fighting the accumulated gas in this way. This may be well enough for emergent purposes, but the proper thing to do is to insist that the gas companies stop the leak in their mains. It may be cheaper for them to go right along wasting gas, but, as the waste has become dangerous to people passing along the streets, the time seems to have come when the leaks should be stopped. There is a good deal of evidence that the gas companies are amply able to do this. If the question of the unhealthiness of the escaping gas does not come in—and when that subject is broached it is always easy to get expert testimony to the effect that it is rather healthy than otherwise—the line ought to be drawn at blowing people up without warning.

Carrying out the enactments of the alien contract labor law, a contractor in Austin, Texas, has been fined a thousand dollars each for importing sixty-four granite stone cutters. And this has brought out a good deal of comment unfavorable to this law. We are not inclined either to uphold or condemn this law, but after all, if the manufacturer is protected it is difficult to see why workmen should not be. The presumption is that these granite cutters were imported because it was cheaper to import them than to hire American workmen to do the work; why the same principle that prevents goods made by foreign labor from competing with those made here should not apply to the laborer, is not quite clear. This law may be bad for the contractor, but it seems so plain that no one is likely to run counter to it unwittingly. It ought to be enforced or repealed, but there seems to be a strong effort to get this Austin contractor free from its penalties.

The Pawtucket Pumping Engine.

In our issue of October, 1878, we published a description of the Pawtucket pumping engine, and gave an account of its performance. This engine was built by the late George H. Corliss, and is probably today the most economical pumping engine in the world. It is a compound engine with cylinders 15" and 30", with 30" stroke. It has been in continuous use since its erection, and has recently been tested by Professor Denton, of the Stevens Institute of Technology. The tests made by Professor Denton were made in the interest of arriving at exact facts, and it is only fair to say that no parties in interest had anything to do with them.

It was found that the engine used 13.7 pounds of water per indicated horse-power per hour, with steam at 130 pounds pressure. The engine indicated 150 horse-power, only six per cent. of which was lost in friction.

This, we believe, will be found to be the most remarkable pumping engine performance of which there is any record. Reckoned from a boiler duty of ten to one, as is customary, the high duty of this engine will be apparent.

The steam cylinders are steam-jacketed, and there are arrangements for re-heating the steam between the two cylinders. Both the steam jackets and the re-heating are supposed to represent economy. But Professor Denton found only a fraction of one per cent. saving in their use.

It is well that the tests of this engine stand upon such excellent authority.

QUESTIONS AND ANSWERS.

Under this head we propose to answer questions sent us, pertaining to our specialty, correctly and according to common-sense methods.

Every question, to insure any attention, must invariably be accompanied by the writer's name and address. If so requested, neither name, correct initials nor location will be published.

(321) H. H., ——, asks: Which consumes the most power—a train of gears, or a system of belting to do the same work? *A.*—It depends upon circumstances, but usually the gearing will consume the most power.

(322) E. H., Denver, Col., asks: Are there any actions detrimental to wrought-iron by using a brass nipple for connecting a cast-iron globe valve to the mud drum of a boiler? *A.*—That will depend on the kind of water used. To be on the safe side, we should use a wrought-iron nipple.

(323) A. J. M'B., Pittsburgh, wishes to know how to lay off the angle of the spiral of a worm, and sends a sketch which he wishes to know whether is right or not. *A.*—The sketch is right; the angle can be laid off by drawing a line equal in length to the circumference of the worm, and at one extremity drawing a line perpendicular to this line, and equal in length to the pitch of the thread. A line joining the extremities of these two lines will be at an angle to the first one, which is equal to the angle of the spiral.

(324) F. D. H., Mottville, N. Y., writes: We desire to drill a ¼-inch hole ⅜ inch into fine tool steel that is as hard as it can be made. To draw the temper would ruin the work. Can you inform us how to make a drill that will cut it? *A.*—The only way we know of is to make a drill of better steel than the piece to be drilled, which may be moistened with turpentine when drilling. If it cannot be done in this way, it may perhaps be ground out by using a piece of brass, copper or steel wire charged with emery and oil, or diamond dust. This can be best done in a machine having a vertical spindle, which can be run at high speed and be fed down by a weight.

(325) F. G. W., Jersey City, N. J., writes: I have been reading your articles on the Sweet lathe, and have been much interested in it; but there is one point that I do not fully understand, and wish you would explain. I would like to know how they keep the belt on the cone pulleys when the head stock is set over for boring taper? I have always found that unless the countershaft and lathe are parallel and level the belt will run off. *A.*—Of course a belt does not run so well when one pulley is at an angle with the other, but where the two cone pulleys are separated a considerable distance, and the pulley steps are considerably crowned, there is no serious trouble. The projecting bead at the edge of each step on the cone pulley helps matters somewhat, and it is also better to have things arranged so that the belt will do the work required without being at all tight.

(326) Apprentice, Providence, R. I., writes: Please give a practical rule for finding the length of a chord between the centers of two holes to be laid off on a circle of any diameter: For instance, I want to lay off 18 holes on a circle 20 inches diameter; what will be the length of the chord between two consecutive holes? *A.*—In our issue of April 25, 1889, in answer to Question 138, we have given a rule for finding, by calculation, the chord of any arc. But for practical purposes, such as you mention, the following method will be the simplest. A degree is the 360th part of the circumference of a circle; hence, divide 360 by the number of the holes to be laid off on the circumference; in the example you have given, we have $\frac{360}{18} = 20$, which indicates the number of degrees in an angle formed by two straight lines drawn from the centers of two consecutive holes on the circumference of the circle to the center of the same circle. With the aid of a protractor, such as is shown in Fig. 127, in our issue of Feb. 19, 1887, draw two lines, making an angle of 20 degrees; from the point in which these lines meet, and with the radius of the given circle (in our example 10 inches) draw an arc terminating in the straight lines previously drawn; a straight line joining the extremities of this arc will be the required chord.

(327) F. F. P., West Medford, Mass., asks: Can you explain the following law, through the query columns, so that one who is not conversant with mechanical formulas could understand it? "The law, according to which the velocity of any material point acted upon by a constant force changes is well known; it is $v = \sqrt{2\,g\,h}$." I understand this to mean that the velocity equals the square root of $(2 \times g\,h)$. Can you explain what $(g\,h)$ represents? The author of the work quoted seems to take it for granted that this is understood. *A.*—The foregoing formula is applicable to falling bodies; v represents the velocity in feet per second; g, the acceleration due to the force of gravity; and h the height in feet through which a body falls in a vacuum. The acceleration g, due to gravity, varies in different latitudes; at the poles, g is equal to 32.2549 feet; at the equator, it is equal to 32.0902 feet; for all practical purposes we take g equal to 32.2 feet. Hence, the given formula will read, the velocity in feet per second attained by a falling body from a state of rest is equal to the square root of the product of 2 $\times$ 32.2 $\times$ height in feet through which the body has fallen at any instant. For the velocity of any body acted upon by a constant force, the following formula is more general: $v = \sqrt{2\,a\,s}$; in which v is the velocity in feet per second; a, the acceleration due to the constant force, and s the space in feet through which the body has been moved.

(328) W. H., Indianapolis, Ind., writes: I am building a small engine and boiler. The engine has two cylinders, 2½ inches diameter and 3 inches stroke. I have the engine finished, and would like to ask a few questions about the boiler. Engines are intended to be run at 500 revolutions per minute, which, according to my calculation, will give two horse-power at 60 pounds boiler pressure. I intend to make the boiler 14 inches diameter, and 30 inches long, with 30 flues 1½ inches diameter if possible. Fire-box to be lined with fire-brick. I intend to make the boiler out of 3-16 inch steel, but am not certain about its safety. Is it heavy enough to stand a pressure of 80 pounds? Is the boiler large enough to keep up a constant pressure of 80 pounds? I intend to use oil as a fuel, and would like to know where I could obtain a suitable burner for such a boiler. If the boiler is not large enough, please state whether it is large enough for one cylinder, and how large it should be for both cylinders. *A.*—You do not give a description of your boiler sufficiently clear for us to form an opinion, but we believe it to be too small. We should prefer an upright boiler 24 inches diameter, 52 inches high, with 18 flues 2½ inches diameter; height of furnace about 18 inches, and length of flues about 22 inches, leaving a receiving chamber about 12 inches deep above the flues. This boiler will be large enough for both cylinders. For one cylinder you will need about one-half the grate surface, and one-half the heating surface—a little more will be better—of the above boiler. A boiler of this kind will not need a fire-brick lining in the furnace; in fact, there is no room for it, and if there was, a fire-brick lining will do more harm than good. Steel of the best quality, 3-16 of an inch thick, double rivet where necessary, will resist a pressure of 80 pounds in a boiler 24 inches diameter; yet steel ¼ of an inch thick will be safer for a boiler of this size. You will find illustrations of burners in our issues of April 14 and June 16, 1888. 2. How much will the power of the engine be increased by gearing it up as per enclosed sketch? *A.*—The power of an engine cannot be increased by intermediate gears or levers of any kind; they will simply change the rate of doing work; but the power of the engine will be constant, so long as the speed of the engine, steam pressure and quantity of steam is not changed.

BUSINESS SPECIALS

Transient Advertisements 50 cents a line for each insertion under this head. About seven words make a line. Copy should be sent to reach us not later than Thursday for the ensuing week's issue.

Gear wheels and g-cutting. Grant, see adv., p. 16.
Link-Belting and Sprocket Wheels.
Send for Catalogue of Link-Belting.
Over 50,000,000 feet of Link-Belt in use.
Link-Belt Engineering Co., Philadelphia and N. Y.
Shafting Straighteners. J. H. Wells, Tampa, Fla.
Steel Name Stamps, etc. J. B. Roney, Lynn, Mass.
25″ Upright Drills. J. E. Snyder, Worcester, Mass.
28″ Upright Drills. J. E. Snyder, Worcester, Mass.
32″ Upright Drills. J. E. Snyder, Worcester, Mass.
36″ Upright Drills. J. E. Snyder, Worcester, Mass.
Worcester (Mass.) Polytechnic Inst. See advt.
"Bradley's Power Hammers, the best in the world." 20 sizes. Bradley & Co., Syracuse, N. Y.
The best Upright Hammers run by belt are made by Jenkins & Lingle, Bellefonte, Pa.
R. Dudgeon, 24 Columbia st., New York. Improved Hydraulic Jacks and Roller Tube Expanders.
"The Bulldozer," a new departure; forging by pressure. M'f'd by Williams, White & Co., Moline, Ill.
Pattern and Brand Letters. Vanderburgh, Wells & Co., cor. Fulton & Dutch sts., New York.
Davis Key-Seating Machines kept in stock by Manning, Maxwell & Moore, 111 Liberty st., N. Y.
Selden Packing for stuffing-box, with or without rubber core. Randolph Brandt, 38 Cortlandt st., N. Y.
Best silk wiping towels for machinery in the market. S. A Smith, 23 S. Canal st., Chicago, Ill.
Ice and Refrigerating Machines, 131 sold, and all successful. David Boyle, 521 Monroe st., Chicago, Ill.
Bit Brass Die Holders, and Bit Brass Taps. S. W. Card & Co., Mansfield, Mass.
Iron Planers from 16″ to 36″ wide by any length. H. C. Pease & Co., Worcester, Mass.
R. G. Du Bois, 715 11th St., Washington, D. C. Procures first class patents on inventions. Write.
Guild & Garrison, Brooklyn, N. Y., manufacture steam pumps, vacuum pumps, vacuum apparatus, air pumps, acid blowers, filter press pumps, etc.
The best emery wheel made is the "Norwich." For particulars send to Montgomery & Co., 105 Fulton st., New York.
For the latest Improved Diamond Prospecting Drill, address the M. C. Bullock Mfg. Co., 138 Jackson st., Chicago, Ill.
The hook on steam engines is being supplanted by the Dill disconnecting device made by the T. C. Dill Machine Company, 726 Girard ave., Phila., Pa.
Most sensitive and durable Damper Regulator made; works within one pound; send for circular. T. Kieley, 11 W. 13th st., New York.
W. H. Hoffman, consulting engineer, 108 Liberty st., room 3, N. Y. Mechanical engineering in all its branches, working drawings for the transmission of power by steam, water, air and electricity.
Steam Boilers; Their management and working on land and sea. By Jas. Peattie Practical facts from 30 years' experience. 230 pages illustrated, 12mo., cloth, $2. Circulars and Catalogue of Books for engineers free. E. & F. N. Spon, 12 Cortlandt st., N. Y.
For foundry or general manufacturing, a compact property in heart of Buffalo, N. Y. 98x380 ft., on two streets, near canal and R. R. Steam-heated brick building ⅓ size of lot, four light, clear floors, two elevators, outside stairs, engine, boiler, main shafting, wagon scales, stables, abundant yard room. For sale cheap. Address M. H., 56 Pearl St., Buffalo.
H. B. Roelker, 22 Cortlandt st., New York, late Sup't Delamater Iron Works, will hereafter manufacture the Delamater Screw Propeller.
Propellers of same pattern and workmanship as formerly made by the Delamater Iron Works. Each designed for its special work at lowest prices.
Consulting Expert and Constructing Engineer.
Estimates made on machinery and on damages.
"Indicator Practice and Steam Engine Economy." By F. F. Hemenway. Contains plain directions for using the indicator, and making all required calculations from the diagram; also the principles of economy in operating steam engines and current practice in testing engines and boilers. Price $2, postpaid. Published by John Wiley & Sons, 15 Astor Place, New York.
"Binders" for the AMERICAN MACHINIST. Two styles, the "Common Sense," as heretofore sold by us, and mailed to any address at $1.00 each, and the "New Handy," mailed at 50c. each. The former has stiff board covers, while the latter has flexible covers, with full page opening flat. Either will hold the entire 52 issues of any volume. AMERICAN MACHINIST PUB'G CO., 96 Fulton st., New York.
Patterson, Gottfried & Hunter (Lim.), 146-150 Centre St., N. Y., carry a complete stock of Brush Copper, Celluvert Fibre, Oiled Paper, Hard Rubber, Rod & Sheet Brass, Brass, Copper & Iron Wire, Self-Hardening Tool Steel, Set & Cap Screws, Machine Bolts, Machine & Wood Screws, Taps & Dies, Files and Twist Drills, Blowers & Forges, Machinery, Tools & Hardware, Gear Wheels, Wood Pulleys, Shafting, Hangers & Belting. General factory supplies.
C. H. De Lamater & Co., New York, have for sale a very desirable lot of machinery and fixtures for Pattern Makers, Brass Founders, Machinists, Riggers, Blacksmiths and Boiler Makers; also stock of boiler iron, plate iron, sheet iron, patterns and pattern lumber, sand and clay, pipe and pipe fittings, shafting, hangers, iron and wood pulleys, belting, bolts, nuts, washers, screws, nails, packing, flasks, and the necessary small tools for iron and brass founders.
"Practical Drawing." By J. G. A. Meyer. The above series of articles, now running in the AMERICAN MACHINIST, should be closely followed by every student. They commenced with October 23, 1886 issue, and up to and including August 29, 1889 issue, 84 articles have been so far published. Copies containing these articles sent by mail to any part of this country or Canada at 5 cents each. AMERICAN MACHINIST PUBLISHING CO., 96 Fulton st., New York.
"Modern Locomotive Construction." By J. G. A. Meyer. The above series of articles, now running in the AMERICAN MACHINIST, are attracting the attention of railway mechanics all over the world. Commencing with the June 27, 1885 issue, 98 articles have thus far appeared up to and including the August 22, 1889 issue. Copies containing these articles sent by mail to any part of the U. S. or Canada, at 5 cents each. AMERICAN MACHINIST PUBLISHING CO., 96 Fulton st., New York.

MANUFACTURES

The Springfield (Ohio) Machine Tool Co. expect to build a new foundry.

Works to be known as the Alabama Car Works are to be established at Oxanna, Ala.

Charles Blue is interested in building up the Wellsburg Foundry Co., at Wellsburg, W. Va.

The Union Steel Screw Co., Cleveland, Ohio, will make extensive improvements in their plant.

The Moore Manufacturing & Foundry Co., Milwaukee, has increased its capital stock to $100,000.

The Howell Wheel Co. will erect a $50,000 foundry for the manufacture of iron wheels at Covington, Ky.

J. M. Bunt is building a new carriage factory at Fremont, Neb. He will invest about $30,000 in the enterprise.

The Ayres Axle Box Manufacturing Co. has been incorporated. The main offices are located in the city of Peoria, Ill.

Laredo, Texas, will soon have a carriage and wagon factory, through the efforts of the Laredo Improvement Company.

The Chicago, Burlington & Quincy Railroad is experimenting with the Hackney water circulator and purifier, and it is said with excellent results.

The Edwards Manufacturing Company, Augusta, Me., talk of building a new print mill to be connected with the new mill now being erected.

The Bushnell Machine and Transfer Company, of Bushnell, Ill., are working on a new tank pump, which they will place on the market early in 1890.

Articles of incorporation have been filed for the Birmingham (Ala.) Coal, Iron and Timber Company. T. A. Hamilton, H. M. Nesmith and J. L. Yancey are the incorporators.

Work on the cotton mill at West Point, Miss., will be begun immediately, as the $300,000 necessary has been raised. It will be 100x300 feet, three stories, of brick, and contain 200 looms and 5,000 spindles.

Snider & Son are erecting a factory for the manufacture of spokes and other wagon materials at Livermore, Ky., and the Coffee Spoke and Felloe Company have purchased a site for their works in the same city.

Auburn Foundry Company, Auburn, Maine, have built a fifty-foot wing to their foundry this season, and enlarged the capacity of the works. They have had a busy season, and are now at work on plenty of orders.

It is reported that Messrs. Burneson & Ackerman, of Mansfield, Ohio, will establish the Ohio Thresher and Engine Co. at Upper Sandusky, Ohio. They will locate there on account of natural gas, and expect to employ 1,000 men.

There has been incorporated at Chicago the Drake Smoke-Consumer and Oil-Fuel Company, to manufacture smoke consumers and oil-fuel appliances; capital, $500,000; incorporators, W. Weare, L. Drake, D. W. Moody, and F. M. Williams.

The Hubbard & Blake Manufacturing Company, who are about to move their factory from Oakland, Me., to Fort Payne, Ala., are now erecting buildings at the latter place. They will employ 150 men in the manufacture of axes, scythes, etc.

A big shoe factory will be built at Springvale, Mass. It is expected that the firm of E. A. Mudge & Co., of East Rochester, N. H., will locate there. The new factory will be double the size of the Burley & Usher concern, and employ something like 800 operatives.

The citizens of Aiken, S. C., have taken steps toward building a yarn mill of from 2,500 to 4,000 spindles, to spin Nos. 30's to 60's. New machinery or second-hand plant that has been run a short time is wanted. Also a water-power plant. E. E. Sell can give particulars.

The Fort Edward (N. Y.) Paper Company has been incorporated, with a capital of $50,000. The managers for the first year are: Amasa Howland, Lansing M. Howland, Fred. D. Howland, John H. Derby, William E. Spier, Frederick H. Parks, Thos. S. Coolidge and Byron Lapham.

The estate of F. W. Richardson, Troy, N. Y, has issued a card that shows very clearly the construction of the balanced slide valve made at the works. This valve is in use on a large number of locomotives, and gives excellent satisfaction. Mechanics generally will be interested in knowing what it is.

The work on the new Edgar-Thomson blast furnaces at Pittsburgh, Pa., is being pushed forward as rapidly as possible. Two new furnaces are being built alongside the present stacks at Bessemer. The foundations have been put down, and everything will be done to complete the new stacks without delay.

The DeKalb Cotton Factory is a new concern at Camden, S. C., which manufactures woolen and cotton goods. The capital stock of the company is to be $100,000, and will be divided into four thousand shares of $25 each. The corporators are W. M. Shannon, A. D. Kennedy, A. N. Burnet, F. M. Zem, H. G. Carrison, J. T. Hay and P. T. Villepigue.

The Pennsylvania Company has recently placed orders for 2,000 freight cars, distributed as follows: Pullman, 500; Lafayette Car Works, 500; Michigan Car Company, 500; and Ohio Falls Car Works, 500. The Pennsylvania Railroad has also given orders otherwheres for 2,000 cars, and it is reported that they intend to build 1,000 cars in their own shops.

The Empire Woolen Co., of Clayville, N. Y., is making quite extensive improvements about the mill. A three-story addition, 25x34 feet, is being made to the western wing, and various other improvements are being made about the premises. The mill is running quite full, and the general appearance indicates a good outlook for the business.

The Michigan Gas Company, which was founded and given its franchise some months ago to lay a pipe in Detroit, Mich., has filed for record a $3,000,000 mortgage, in favor of the Central Trust, of New York, to secure funds for the construction of their pipe lines to the Ohio State line, where they will unite with a line tapping the natural gas fields of Ohio.

The St. Louis (Mo.) Refrigerator and Wooden Gutter Co. have erected a large brick addition, 70x220 feet, to their local factory, which will be devoted to the manufacture of baby carriages, iron express wagons, and iron wheels. The company are also putting in lathing machines at their mills at Gurdon and Arkadelphia, Ark., for making yellow pine plastering lath and wire fence lath. Trade in yellow pine is said by them to be quiet.

Recently, at Pittsburgh, the entire plant of the Sharon Stove Company, representing an investment of over $60,000 when it was erected five years ago, was sold by P. L. Kimberly, of Sharon, and the Iron City National Bank, of Pittsburgh, who held it since the company's failure two years ago, to Graff & Hugus, of the latter city. It is stated that the purchasers will remove their business to Sharon as soon as possible, and keep the plant in steady operation, employing about 150 men. The works have been idle over a year.

The Pennsylvania Lumber Company will remove their saw and planing mills at Leeper, Mo., to some point in Southern Arkansas this winter. Their plant at Leeper is an extensive one, including as it does a well-built narrow-gauge railway fifteen miles in length. In the last five years, 20,000 acres of timber have been cut off and manufactured. The new location has not been fully decided upon as yet. The plant will be enlarged and improved so as to embrace the latest features in mill construction and arrangement.

The plans of the Weyer Mill Company, at East Superior, Wis., contemplate one of the largest lumber-cutting plants in the United States. The company have already secured over half the timber lands of Douglass county, comprising all the pine lands of the Chicago, St. Paul, Minneapolis & Omaha Railway Company, together with their immense hard wood tracts. The work of constructing this plant will be begun soon. The sawing capacity will be 300,000 feet of lumber per day. The plant will employ, when complete in all its branches, about 2,000 men.

The gentlemen who propose to erect and operate a stove foundry at Fort Worth, Texas, are M. A. McLaughlin, of Manhattan, Kan.; W. H. Vanderworker, of Green Island, N. Y.; and J. V. Vrooman, of Schenectady, N. Y. They have bought eighteen acres of land, one-fourth of a mile west of Fort Worth, on the Texas & Pacific, and Messrs. A. M. Carter, J. J. Roche and C. Y. McClellan have donated fifteen acres. They propose and guarantee to expend $50,000 in buildings of brick and machinery. The foundry will have capacity sufficient to employ 100 hands.

The work of clearing the site of the old Plunkett Mill at Adams, Mass., to make way for the new cotton mill, has been begun. The foundations of the old mill, which was burned about two years ago, remain, and their removal will take some time. As soon as this is completed, work on the new building will begin, and the projectors of the new industry hope to have the roof on before winter. The mill will manufacture cotton goods, and about 700 looms will be run, about 600 hands being employed. The capital is furnished by a stock company, organized by W. C. Plunkett's Sons.

William Tod & Co., of Youngstown, Ohio, report orders for heavy machinery that will tax their capacity for four months. Their work is largely on special designs by their own engineers, such as the Tyre mill engines for The Latrobe Steel Works, the Blooming mill engines for The Chester Rolling Mill Co., the 700 horse-power compound condensing engine for the California Electric Light Co., a 24-inch diameter by 24-foot stroke hydraulic accumulator for the Avery Stamping Co., etc. The Carnegie Mills, of Pittsburgh, have just given them their eleventh order for Standard Porter-Hamilton engines.

The adoption of the water contract with the Lehigh Valley Railroad Company by Newark, N. J., will perhaps be followed by a contract with what is substantially the same organization by Jersey City. Newark is to have the new supply in 1892, and is to pay $4,000,000 down, and $2,000,000 eleven years later. Jersey City is expected to buy by the million gallons. As the company will get a liberal price for the works from Newark, and receive about $200,000 a year from Jersey City, without additional plant, it is about to undergo a comfortable financial experience. The water is to be drawn from the mountain sources and will be pure. The next movement of the water companies will, it is said, be to make a contract to supply the "dry goods district" of New York City. The rate named in the offer to New York is $90.00 a million gallons, while that to Jersey City is $39.00, with a deduction for a larger supply.

Machinists' Supplies and Iron.

NEW YORK, Aug. 24, 1889.

Iron—American Pig.—There is no change of consequence in prices, and stock transactions continue to be moderate, but of such a nature as to create a hopeful feeling. We quote, Standard Northern brands, No. 1 X Foundry, $17 to $18; No. 2, $16 to $17. Southern brands, No. 1, $16.75 to $17.25; No. 2, $16 to $16.50; Grey Forge, $15 to $15.25.

✲WANTED✲

"Situation and Help" Advertisements only inserted under this head. Rate 30 cents a line for each insertion. About seven words make a line. Copy should be sent to reach us not later than Saturday morning for the ensuing week's issue.

Wanted—Position as draftsman or foreman machinist by a practical man. D. M., AM. MACHINIST.

Wanted—A first-class tool maker. The E. Ingraham Co., Bristol, Conn.

Foreman pattern maker, 10 years' experience in charge of men, is at liberty to engage. Address X. Y. Z., care of AMERICAN MACHINIST.

Wanted—Situation by first-class machinist; good designer, tool maker and experimenter; any part of the country. Address Box 16, AMERICAN MACHINIST.

Wanted—Foreman for shop making iron pipe fittings, iron valves, radiators, and steam-heating specialties. "Manufacturer," AMERICAN MACHINIST.

Wanted—An educated and experienced draftsman; give references, and state salary. Address Davies & Thomas, Catasauqua, Lehigh Co., Pa.

Situation wanted as foreman pattern maker by first-class man; 10 years' experience as foreman. Address Box 20, 121 Fourth av., New York City.

Designer open to engagement in responsible position; special success in fine automatic machinery; experienced and practical in modern machine practice, and as supt. S., care AMERICAN MACHINIST.

Wanted—A first-class master mechanic; must be familiar with boiler as well as mach. work. Address, stating age, qualifications and salary expected, Utley Wedge, care of Standard Oil Co., Cleveland, Ohio.

Wanted—First-class machinists. None others need apply. Wages $2.25 per day of 10 hours, with chance for advancement if found worthy. The Pond Machine Tool Co., Plainfield, N. J.

Wanted—Draftsman on engine and pump work; state where last employed, age, experience, and salary at which you will work. Address X, care of AMERICAN MACHINIST.

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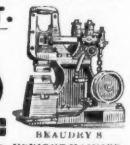

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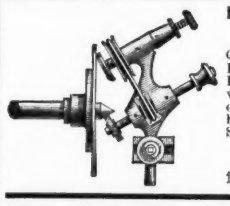

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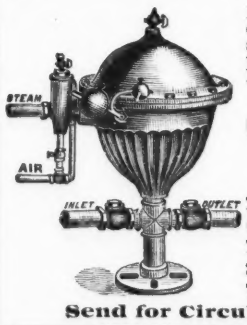

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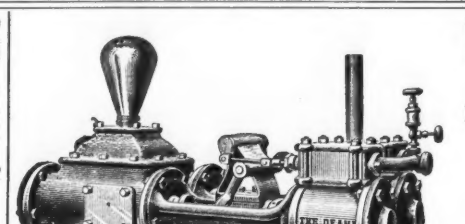

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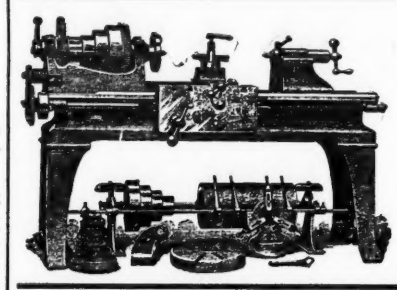

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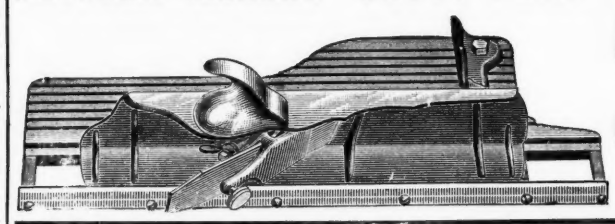

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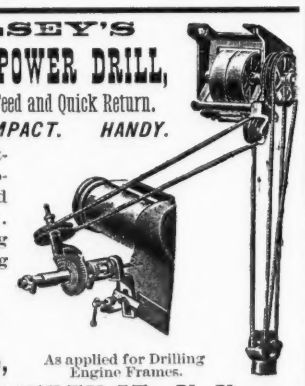

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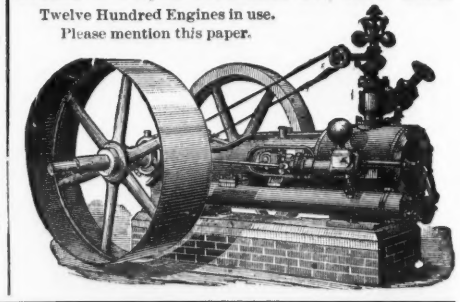

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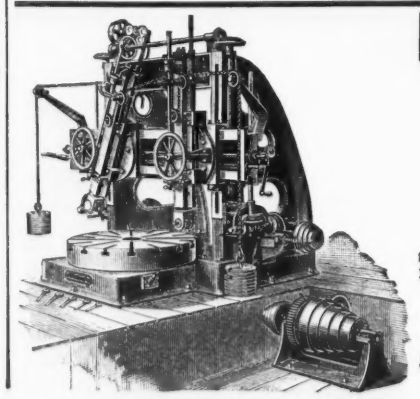

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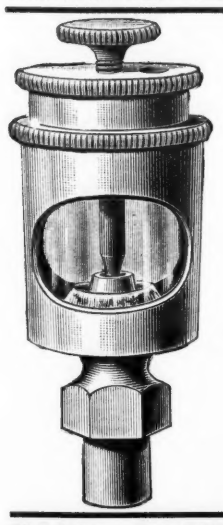

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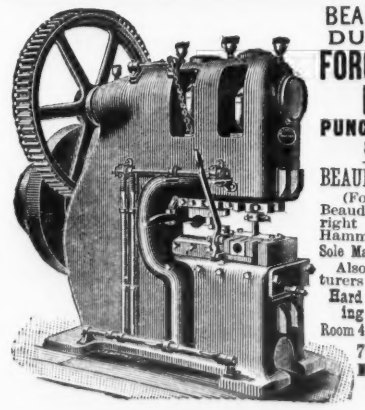

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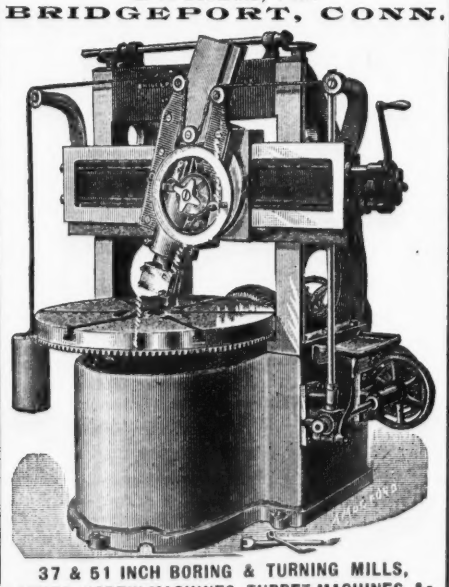

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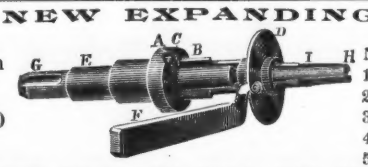

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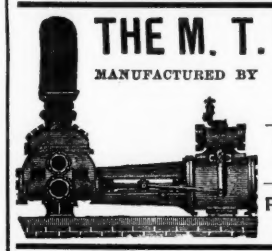

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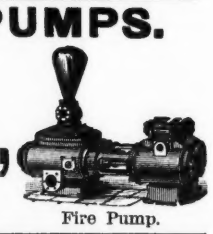

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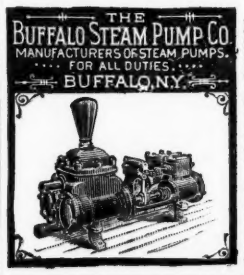

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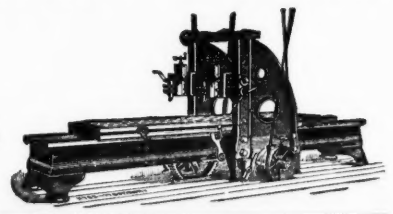

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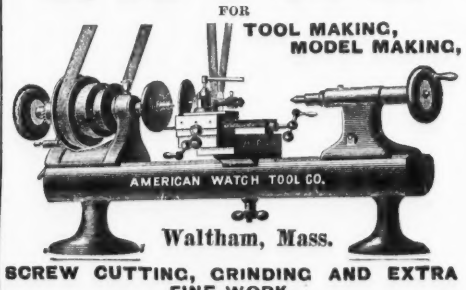

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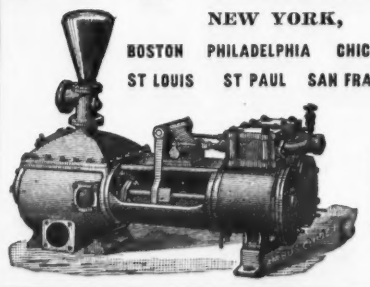

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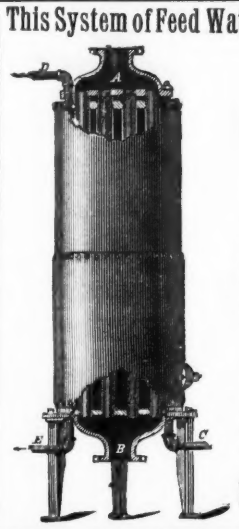

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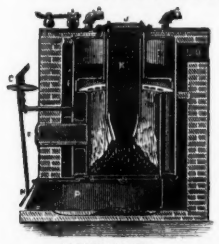

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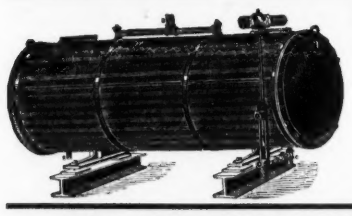

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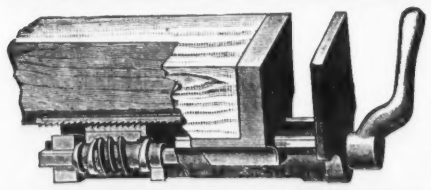

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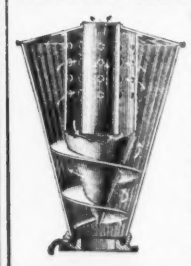

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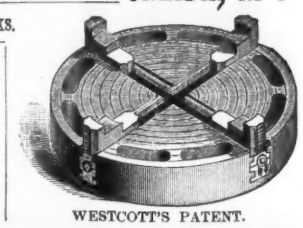
13 1-4 in.	15 in.
16 in.	18 in.
18 1-2 in.	21 1-2 in.
21 1-4 in.	26 in.
24 in.	30 in.
30 in.	36 in.
36 in.	43 in.



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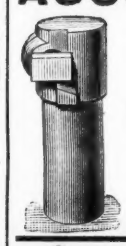

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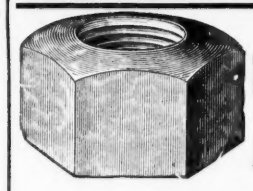

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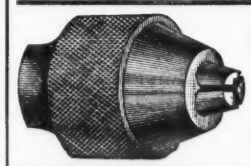

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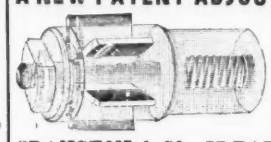

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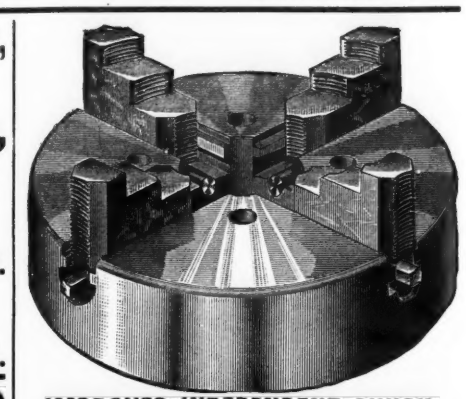

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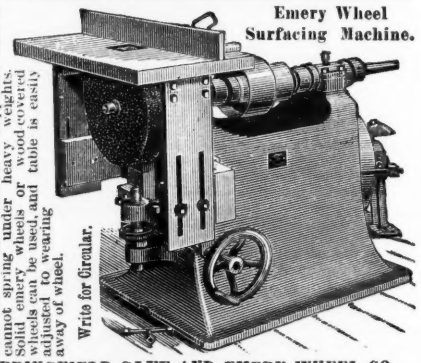

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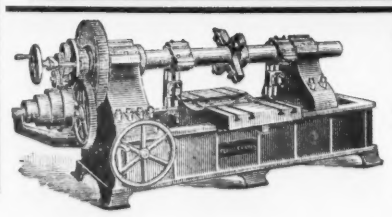

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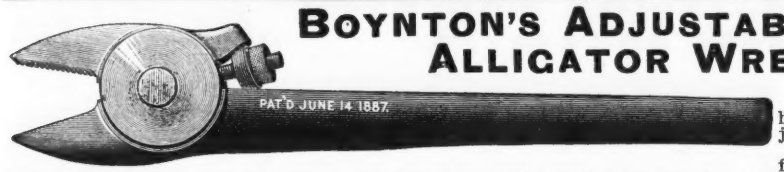

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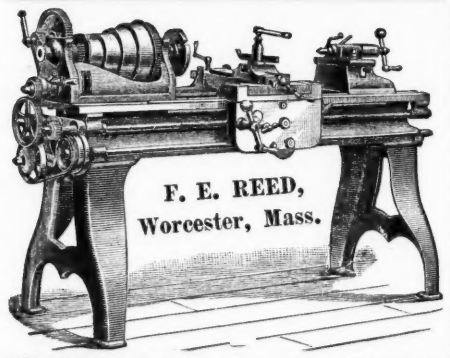

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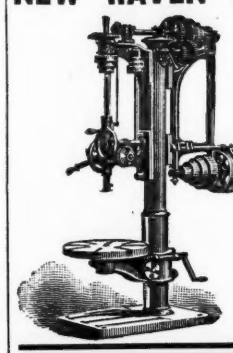

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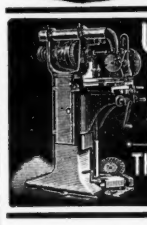

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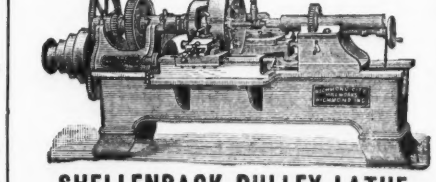

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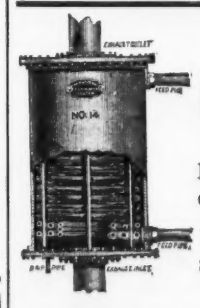

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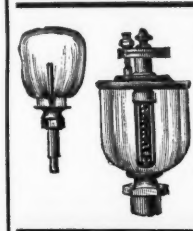

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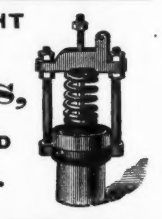

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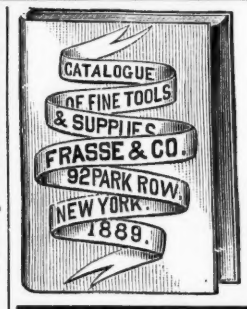

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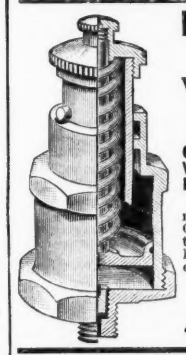

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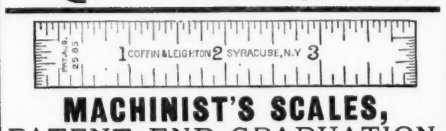

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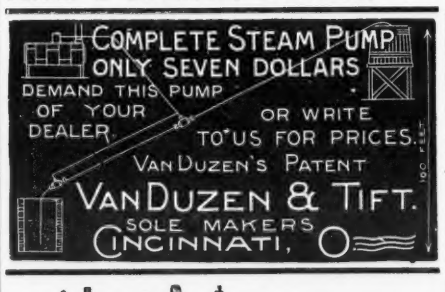

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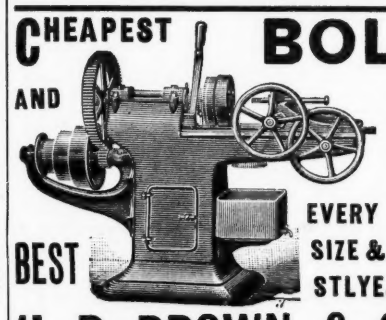

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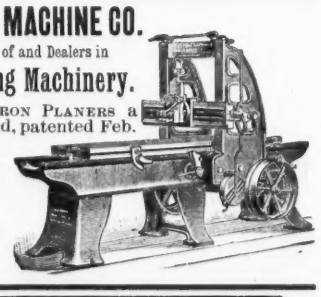

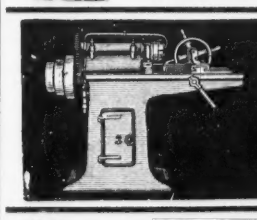

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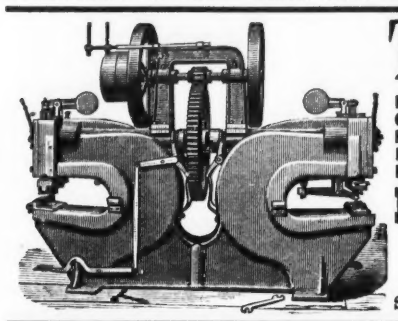

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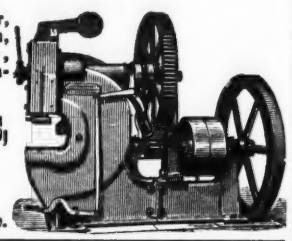

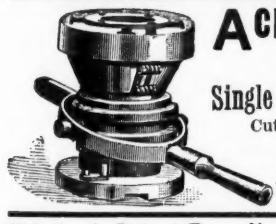

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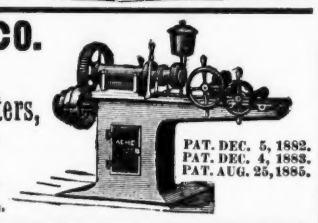

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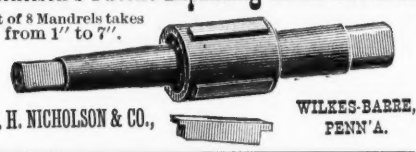

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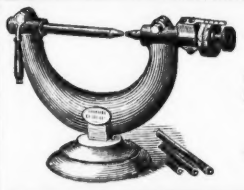

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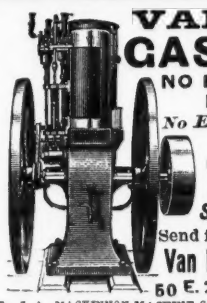

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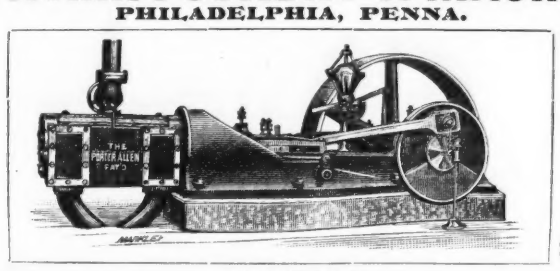

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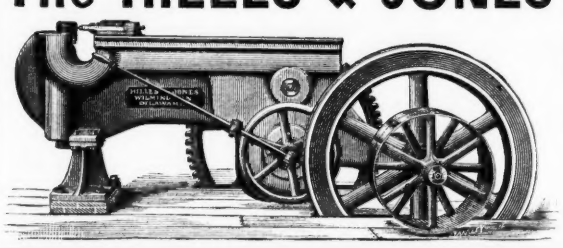

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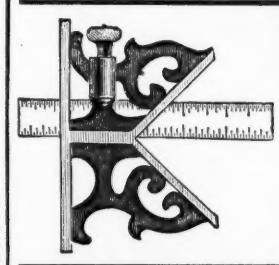

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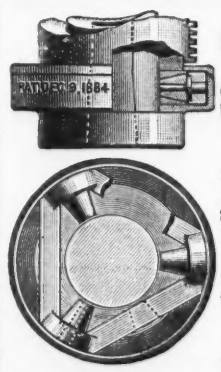

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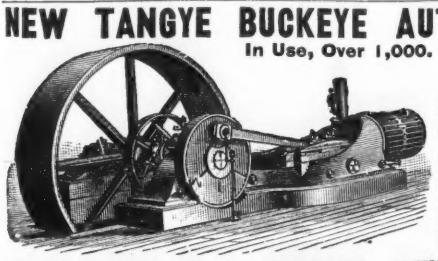

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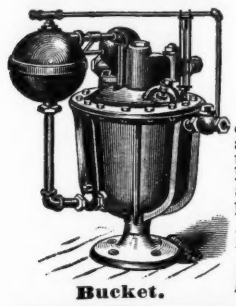

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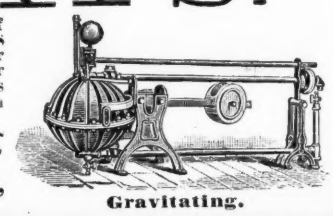

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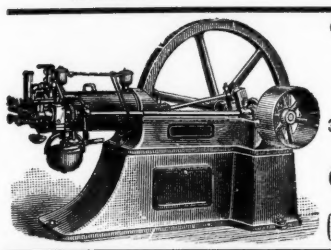

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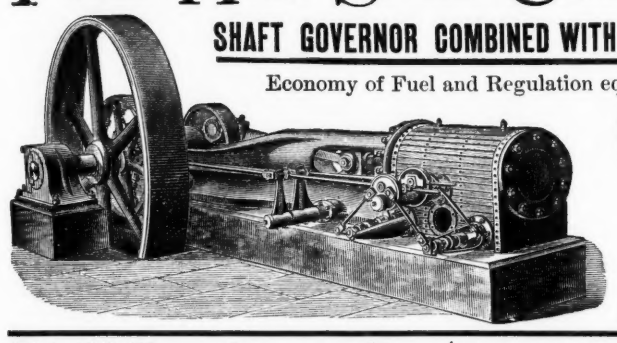

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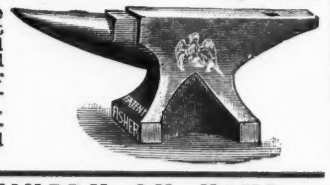

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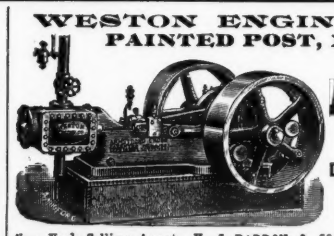

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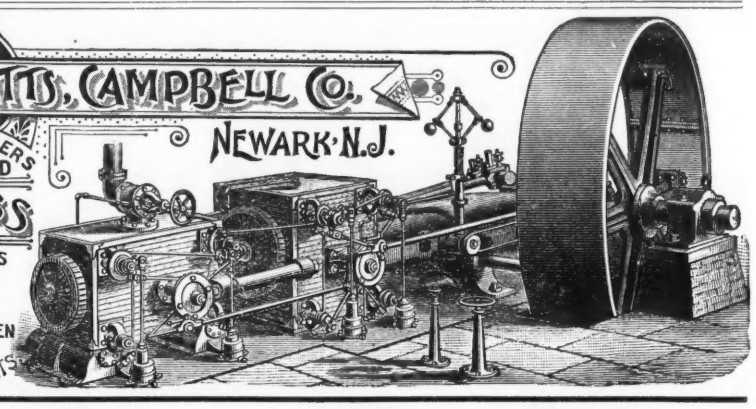

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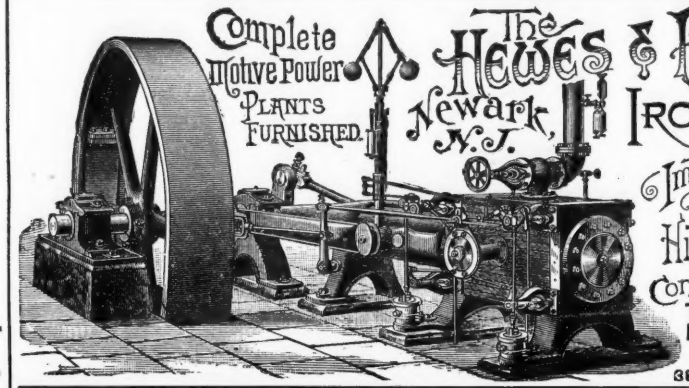

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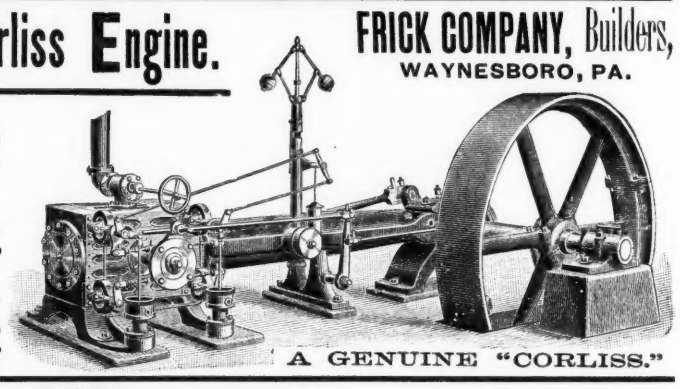

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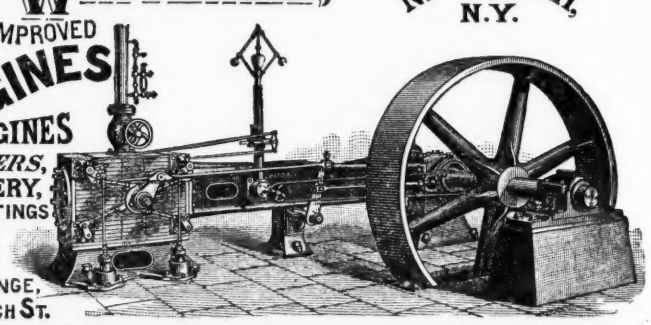

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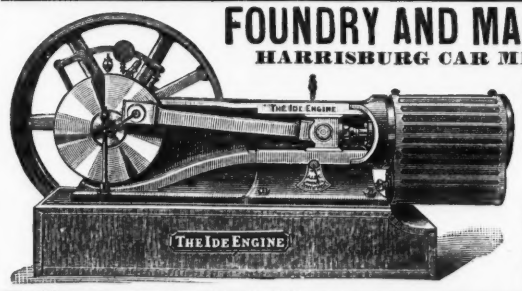

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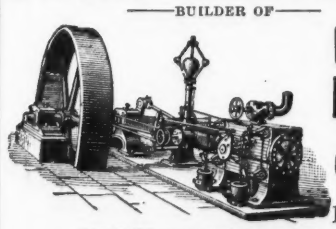

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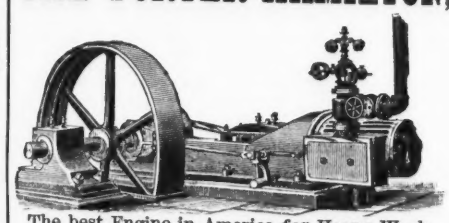

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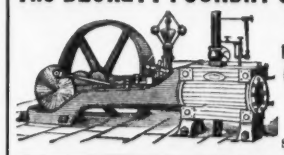

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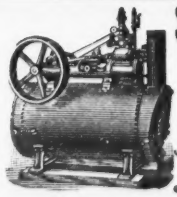

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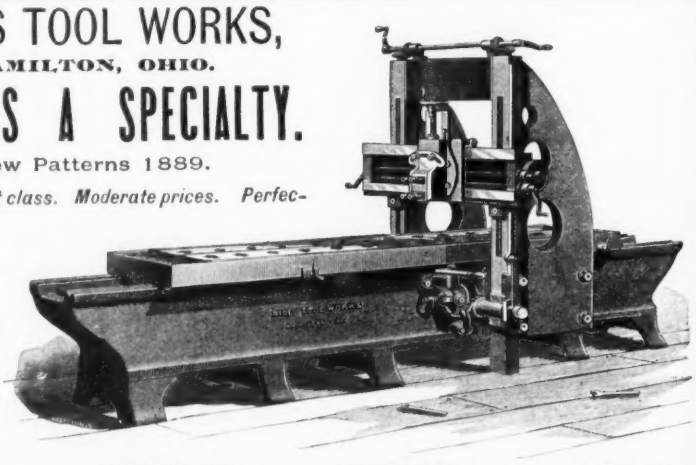

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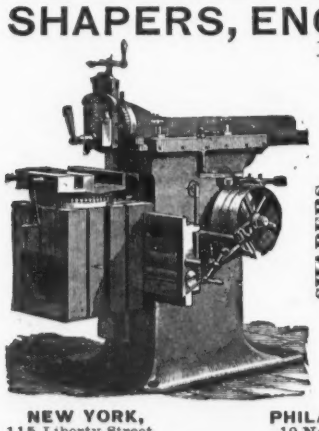

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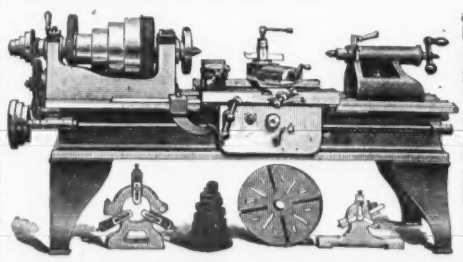

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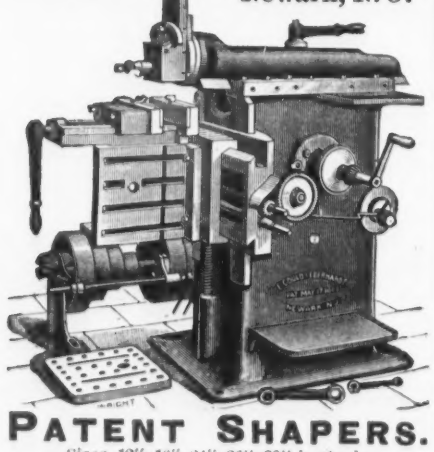

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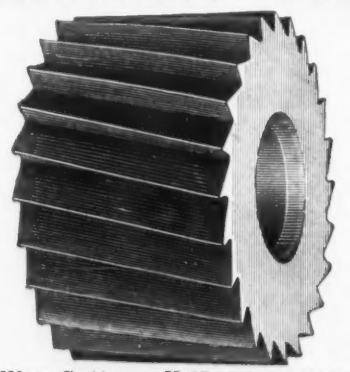

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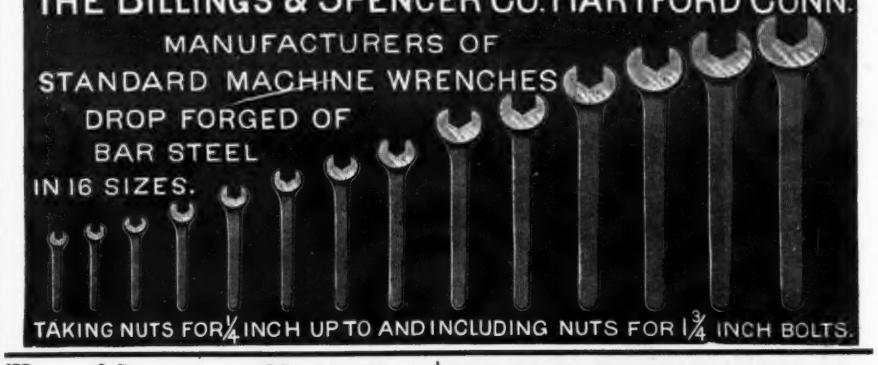

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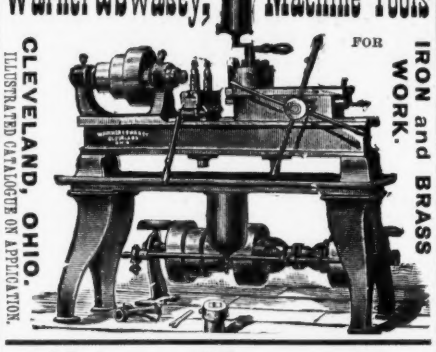

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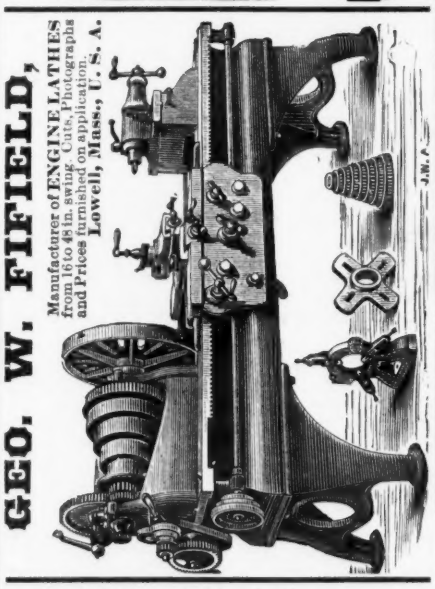

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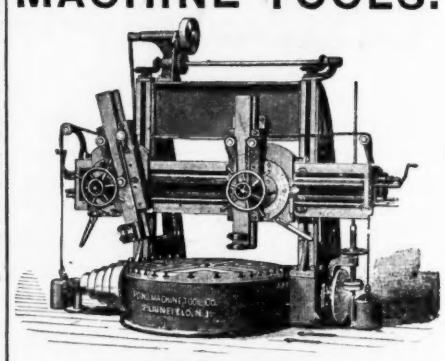

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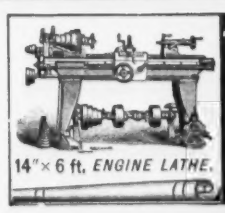

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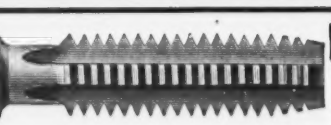

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